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ERRATA

Page 130, line 5, *for* 267, *read* 389.
,, 234, ,, 12, *for* Moisture . . . 97, *read* Moisture . . . 9·7

BULLETIN OF THE IMPERIAL INSTITUTE

VOL. V, 1907

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THE IMPERIAL INSTITUTE

OF THE

UNITED KINGDOM, THE COLONIES AND INDIA

THE Imperial Institute was erected at South Kensington as the National Memorial of the Jubilee of Queen Victoria, by whom it was opened in May 1893.

The principal object of the Institute is to promote the utilisation of the commercial and industrial resources of the Empire by arranging comprehensive exhibitions of natural products, especially of India and the Colonies, and providing for their investigation and for the collection and dissemination of scientific, technical and commercial information relating to them.

Until the end of 1902 the Imperial Institute was managed by a Governing Body, of which H.R.H. the Prince of Wales (now H.M. the King) was President, and an Executive Council, including representatives of the Indian Empire and of all the British Colonies and Dependencies. In 1900 the building became the property of H.M. Government, by whom the western portion and galleries were leased to the Governing Body of the Imperial Institute, the greater part of the eastern and central portions being assigned, subject to rights of usage, for occupation by the University of London. In July 1902 an Act of Parliament was passed transferring the management of the Imperial Institute to the Board of Trade, assisted by an Advisory Committee including representatives of India and the Colonies, as well as of the India and Colonial Offices, the Board of Agriculture, and the Board of Trade. This Act took effect on January 1, 1903.

On October 1, 1907, in virtue of an arrangement made with the Board of Trade and with the approval of the Secretary of State for India, the management of the Imperial Institute was transferred to the Secretary of State for the Colonies, subject to the responsibility of the Board of Trade under the Act of 1902. A Committee of Management of three members, one nominated by each of the three Government Departments chiefly concerned,

has been appointed, and at present consists of the Right Hon. Sir Cecil Clementi Smith, G.C.M.G.; Sir Alfred Bateman, K.C.M.G.; and Colonel Duncan Pitcher (late Indian Army).

The first Director of the Imperial Institute was Sir Frederick Augustus Abel, Bart., G.C.V.O., K.C.B., F.R.S., who held the office until his death in the autumn of 1902. The present Director is Professor Wyndham Dunstan, M.A., LL.D., F.R.S., who was appointed in 1903.

The staff of the Imperial Institute includes officers with special qualifications in the sciences of chemistry, botany, geology, mineralogy, and in certain branches of technology, in their relation to agriculture and to the commercial utilisation of economic products.

The following are the principal Departments of the Institute.

Indian and Colonial Collections.—The Collections of economic products, etc., illustrative of the general and commercial resources of India and the Colonies, are arranged, together with other exhibits, on a geographical system in the public galleries of the Imperial Institute.

The following British Colonies and Dependencies are represented by Collections—

Canada, Newfoundland; Jamaica, Turks Islands, British Honduras, British Guiana, Bahama Islands, Trinidad and Tobago, Barbados, Windward Islands, Leeward Islands, Bermuda Islands; Falkland Islands; Australia: New South Wales, Victoria, Queensland, Tasmania, South Australia, Western Australia, New Zealand; Fiji; Cape of Good Hope, Natal, Transvaal, Orange River Colony, Rhodesia, Nyasaland, St. Helena; Gambia, Sierra Leone, Gold Coast, Northern Nigeria, Southern Nigeria; British East Africa, Zanzibar and Pemba; Uganda; Somaliland; the Anglo-Egyptian Soudan; Malta; Cyprus; Ceylon; Hong Kong; Mauritius; Seychelles; Straits Settlements and Federated Malay States; and India.

The Indian and Colonial Collections are open free to the public daily, except on Sundays, Good Friday and Christmas Day, from 10 a.m. to 5 p.m. in summer, and from 10 a.m. to 4 p.m. in winter.

Special arrangements are made for the conduct of schools and institutions desirous of visiting the Indian and Colonial Collections for educational purposes.

A stand has been opened in the centre of the main gallery

to facilitate the supply of general information and the distribution of literature. Pamphlets, circulars, handbooks, etc., containing information relating to the commerce, agriculture, mining, and other industries of the principal British Colonies, and also to emigration, are available for gratuitous distribution or for sale. The publications of the Emigrants' Information Office, established by the Colonial Office, may also be obtained. The principal Indian and Colonial newspapers may be seen on application. An officer of the Institute is in attendance at this stand, which is in telephonic communication with the Departments in the main building.

In 1907 the public galleries were visited by 123,016 persons, and 14,866 Colonial and Indian publications were distributed.

The Scientific and Technical Department.—The research laboratories of this Department, which occupy the second floor of the Imperial Institute, were established in order to provide for the investigation of new or little-known natural products from India and the Colonies and of known products from new sources, with a view to their utilisation in commerce, and also to provide trustworthy scientific and technical advice on matters connected with the agriculture, trade and industries of India and the Colonies.

The work of this Department is chiefly initiated by the Government of India and the Home and Colonial Governments. Arrangements have been also made by the Foreign Office, whereby British representatives abroad may transmit to the Department for investigation such natural products of the countries in which they are appointed to reside as are likely to be of interest to British manufacturers and merchants.

Materials are first investigated in the research laboratories of the Department, and are afterwards submitted to further technical trials by manufacturers and other experts, and finally are commercially valued.

Except under special circumstances investigations are not undertaken for private individuals.

A Reference Sample Room is maintained in this Department, in which are arranged samples of the principal materials which have been investigated and commercially valued during recent years, and as to which full information is available.

The Scientific and Technical Department is now working in co-operation with the Agricultural and Mines Departments in

the Colonies, whose operations it supplements by undertaking such investigations and inquiries as are of a special scientific and technical character connected with agricultural or mineral development, as well as inquiries relating to the composition and commerical value of products (vegetable and mineral) which can be more efficiently conducted at home in communication with merchants and manufacturers, with a view to the local utilisation of these products or to their export.

A very large number of reports on these subjects have been made to the Governments of India and the Colonies, a first instalment of which has been printed in a volume of *Technical Reports and Scientific Papers*, published in 1903, whilst a selection of the later reports has been printed in the *Bulletin of the Imperial Institute.*

Mineral surveys, under the supervision of the Director of the Imperial Institute, and conducted by surveyors selected by him, are in progress in Ceylon, Northern Nigeria, Southern Nigeria, and Nyasaland, and preliminary arrangements of a similar nature have been made in connection with British East Africa and with the Anglo-Congolese Boundary Commission in Uganda. All minerals found which are likely to be of commercial importance are forwarded to the Imperial Institute, where they are examined and their composition and commercial value ascertained. Reports by the Director on the results of the mineral exploration in Ceylon, Northern Nigeria and Southern Nigeria have been printed in the Miscellaneous Series of Colonial Reports. A Report on the entire work of the Imperial Institute was presented to Parliament in 1906 (Cd. 3116).

In connection with the operations of the Agricultural Departments in West Africa, and with a view to correlating their work and that of the Imperial Institute, a Superintendent of Agriculture for British West Africa (Mr. G. C. Dudgeon) has been appointed, who visits West Africa each year, and on his return has his head-quarters at the Imperial Institute.

Library and Reading-Rooms.—The library and reading-rooms of the Imperial Institute contain a large collection of Indian and Colonial works of reference, and are regularly supplied with the more important official publications, and with many of the principal newspapers and periodicals of the United Kingdom, India and the Colonies.

The library and reading-rooms are on the principal floor, and admittance to them is obtained through the entrance at the west (Queen's Gate) end of the building. These rooms are available for the use of Life Fellows of the Imperial Institute, and of other persons properly introduced. Books and newspapers may be consulted for special purposes by permission.

Colonial Conference Rooms.—Three large rooms, specially decorated and furnished, are reserved on the principal floor for use by representatives of the Colonies for meetings and receptions.

The Cowasjee Jehanghier Hall.—The Bhownagree corridor and rooms in connection with this Hall are in the occupation of the Indian Section of the Imperial Institute, whilst the Hall is available for lectures, meetings, etc.

The "Bulletin of the Imperial Institute" is published quarterly, price one shilling (annual subscription 4*s*. 8*d*., including postage), and may be purchased at the Imperial Institute or from Messrs. Eyre and Spottiswoode, East Harding Street, Fleet Street, London, E.C., or from agents in India and the Colonies. The *Bulletin* contains records of the principal investigations conducted for India and the Colonies at the Imperial Institute, and special articles chiefly relating to progress in tropical agriculture and the industrial utilisation of raw materials (vegetable and mineral).

The following Societies have their head-quarters at the Imperial Institute—

British Women's Emigration Association.—The British Women's Emigration Association has been assigned an office on the first floor, which is open daily from 10 a.m. to 4 p.m., and advice and information respecting emigration and prospects for women in the Colonies may be obtained there free of charge. This Association works in co-operation with the Emigrants' Information Office in Westminster.

Colonial Nursing Association.—This Association has been assigned an office on the first floor of the Imperial Institute. Its principal object is the selection of trained hospital and private nurses for service in the Crown Colonies and other British Dependencies.

African Society.—This Society, which is concerned with the discussion and publication of all matters connected with British African Possessions, has been assigned an office on the Mezzanine floor, and holds meetings at the Imperial Institute for the discussion of African questions. The *Journal of the African Society* is published quarterly.

THE IMPERIAL INSTITUTE

Advisory Committee.

(Appointed under the provisions of the Imperial Institute Transfer Act, 1902.)

	Appointed by
The Right Hon. Lord James of Hereford, G.C.V.O. The Right Hon. Lord Allerton. Sir F. Hopwood, K.C.B., K.C.M.G. Sir Alfred Bateman, K.C.M.G. H. Llewellyn Smith, Esq., C.B. (One vacancy to be filled.)	The Board of Trade.
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Sir Thomas Elliott, K.C.B.	The Board of Agriculture.
The Right Hon. Lord Strathcona and Mount Royal, G.C.M.G.	The Government of the Dominion of Canada.
Captain Muirhead Collins, C.M.G.	The Federal Government of the Commonwealth of Australia.
The Hon. W. Pember Reeves.	The Government of New Zealand.
The Hon. Sir W. Arbuckle, K.C.M.G.	The Government of Natal.

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Sir Alfred Bateman, K.C.M.G.
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Director of the Imperial Institute.

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Scientific and Technical Department.

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MINERAL SURVEYS.

Mineral Surveys of Ceylon, Southern Nigeria, Northern Nigeria and Nyasaland are being made under the supervision of the Director of the Imperial Institute by the following officers; the chemical investigation and valuation of the minerals collected by the Surveyors being conducted at the Imperial Institute. Preliminary surveys have also been undertaken in British East Africa and Uganda.

Ceylon: J. PARSONS, B.Sc. (Lond.), F.G.S.
J. A. DANIEL, B.A. (Cantab.).

Southern Nigeria: A. E. KITSON, B.A. (Melbourne), F.G.S.
S. M. OWEN, A.R.S.M.

Northern Nigeria: J. D. FALCONER, M.A., D.Sc. (Edin.), F.G.S.
A. LONGBOTTOM, B.A. (Cantab.).

Nyasaland Protectorate:
A. R. ANDREW, B.Sc. (N.Z.), F.G.S.
T. E. G. BAILEY, B.A. (Cantab.).

Uganda: J. E. COATES, B.A. (Cantab.) (*attached to the Anglo-Congolese Survey Commission*).

British East Africa: K. JOLL.

Colonial Collections.

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H. SPOONER.

Indian Collections.

Superintendent:

C. E. JONES, B.Sc. (Lond.), F.L.S.

BULLETIN
OF THE
IMPERIAL INSTITUTE

1907. Vol. V. No. 1.

SCIENTIFIC AND TECHNICAL DEPARTMENT.

RECENT INVESTIGATIONS.

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Indian and Colonial Governments concerned.

FIBRES OF BRITISH WEST AFRICA.

PART I.

NUMEROUS fibre-producing plants grow freely in the British West African Colonies and Protectorates, and offer a promising field for development. The object of the present article is to draw attention to the more important of these plants, to indicate the chief characteristics and economic value of their fibres, and to give an account of the work already done in connection with their cultivation and scientific and technical investigation. The question of cotton growing is not included here, as this has already been dealt with in Professor Dunstan's *Report on Cotton Cultivation in the British Empire and in Egypt* (Cd. 2020), and in this *Bulletin* (1905, **3**. 49), as well as in various publications of the British Cotton Growing Association.

During the present year a collection has been made of some of the fibre plants of British West Africa by Mr. G. C. Dudgeon, Superintendent of Agriculture for British West African Colonies and Protectorates, and much of the information which he has obtained has been incorporated in the following account.

Fibre plants are not at present cultivated in West Africa as field crops for the exclusive production of fibre, with the single exception of a species of *Hibiscus*, probably *H. lunariifolius*, which is grown in the Bassa and Nupe Provinces of Northern Nigeria in patches up to half an acre in extent. It is considered probable by Mr. Dudgeon that as the people of these Provinces live on the banks of, or in proximity to, the Niger and Benue, they require more fibre for the manufacture of rope and cordage for the trading canoes than can be obtained from wild plants, and that for this reason they have recourse to cultivation.

For the purposes of this article it has been found convenient to class the various fibres into three groups, viz. (1) jute-like fibres, (2) fibres suitable for the manufacture of cordage, and (3) miscellaneous fibres.

JUTE AND SIMILAR FIBRES.

The deficiency in the supply of jute to the United Kingdom, which has been brought about by the increased consumption of the fibre in the Indian mills, has led jute spinners in Dundee to direct their attention to the possibility of obtaining the product from West Africa. This was pointed out in a previous article in this *Bulletin* (1905, **3**. 251), in which the prospects of jute growing in West Africa were discussed.

Considerable attention has been devoted to this matter in Sierra Leone, and much interest has been taken in it by the Government of that Colony. A Government agent was appointed at the beginning of the year 1905 to make a study of the fibres of the Ronietta District, and the results of this inquiry were embodied in a report, copies of which were forwarded to the Imperial Institute, together with samples of the three fibres mentioned in it. The samples were examined in the Scientific and Technical Department, and an account of their quality and commercial value was given in the article in this *Bulletin* already referred to.

Corchorus species.

Another sample of fibre—supposed to be true jute—from the Bandajuma District, was forwarded to the Imperial Institute by

the Government of Sierra Leone in July 1905. This product was rather harsh, of somewhat poor strength, and from 3 to 4 feet long. On chemical examination it gave results which are compared below with the corresponding figures furnished by a sample of Indian jute of "extra fine" quality :—

	Present sample from Sierra Leone.	Indian jute of "extra fine" quality.
	Per cent.	*Per cent.*
Moisture	11·9	9·6
Ash	0·4	0·7
α-Hydrolysis (loss)	7·4	9·1
β-Hydrolysis (loss)	10·5	13·1
Cellulose	79·9	77·7

Length of ultimate fibre: 1·4–3·0 mm. or 0·05–0·12 in.

These results indicate that as regards its chemical composition and behaviour the fibre is of excellent quality, since it contains a high percentage of cellulose and suffers a comparatively small loss when boiled with dilute alkali (α- and β-hydrolysis). In these respects this product is somewhat superior to the sample of Indian jute referred to above. The length of the ultimate fibre is identical with that of true jute. The amount of moisture contained in the Sierra Leone fibre under ordinary atmospheric conditions is, however, greater than the amount usually present in samples of true jute, and, moreover, the former product is weaker than a good jute. Microscopic examination showed that the fibre was certainly a member of the jute class, but was inadequate to prove identity with jute itself.

Two species of *Corchorus* are grown in Sierra Leone as vegetables, but are not worth consideration as possible sources of fibre in the present state of agriculture of the Colony. One species is called "Gambia Crincrin," "Gringri" (Mendi language), and "Angcrincrin" (Timani language). The other is also known as "Crincrin" in Sierra Leone, "Eyo," "Ayoa," or "Owedu" (Yoruba language). These species are probably not indigenous, and are perhaps referable to *C. acutangulus* and *C. tridens.*

During the year 1906 a quantity of true jute seed was forwarded to the West African Colonies from India for the purpose of attempting the cultivation of the plant. It was proposed that experiments should be carried out at first on a small scale in order to ascertain the adaptability of Indian jute to West African conditions.

Hibiscus lasiocarpus (?).

The next sample of fibre of the jute class sent from Sierra Leone to the Imperial Institute for examination was possibly derived from *Hibiscus lasiocarpus*, and consisted of ribbons of fibre which appeared to have been stripped from the bark, but to have undergone little or no further preparation. The product was of mixed and uneven character, some of the strips being coarse and gummy, whilst others were fine and silky. The fibre was of a pale buff colour with slight lustre, and was of fair strength and irregular length, varying from 3 feet to 5 feet 8 inches. It was stated that the plant yielding this product is found in all parts of the Colony, and that the fibre is extensively used for making ropes, baskets, etc.

A specimen of the fibre, cleaned as far as possible by hackling, was submitted to chemical examination and furnished the results given in the following table, to which are added, for convenience of comparison, those yielded by a sample of *Hibiscus cannabinus* fibre from Madras:—

	Hibiscus species, Sample No. 2, from Sierra Leone. *Per cent.*	*Hibiscus cannabinus* from Madras. *Per cent.*
Moisture	9·2	10·1
Ash	0·7	2·0
α-Hydrolysis (loss)	12·5	8·8
β-Hydrolysis (loss)	17·5	13·7
Acid purification (loss)	3·1	2·5
Cellulose	75·7	74·8
Length of ultimate fibre	2·1–3·05 mm. or 0·08–0·12 in.	1·5–4·0 mm. or 0·06–0·16 in.
Length of staple	3 ft. to 5 ft. 8 in.	Average 7 ft.

These results show that this sample resembles the *Hibiscus cannabinus* fibre in general composition, but suffers a greater loss on hydrolysis, probably due to the fact that it has not been carefully cleaned and prepared.

The commercial experts reported that the fibre was of fair length and strength and of good colour, and that if the material were shipped in quantities of 20 to 50 tons at a time, it would sell freely at £15 to £16 per ton (February 1906).

The fibre is somewhat similar to jute, and there can be no doubt that its value for spinning purposes could be much enhanced by the exercise of greater care in its preparation.

In January 1906 samples of three fibres of the jute class were forwarded to the Imperial Institute from Sierra Leone, together with herbarium specimens of the plants from which they were derived. These fibres are known locally as "Kowe" or "Corwey," which was identified as *Hibiscus quinquelobus;* "Napunti," which was recognised as *Honckenya ficifolia;* and "Borfroko" or "Abala," the identity of which could not be determined from the botanical specimens supplied. A description of these fibres and the results of their examination are given below.

Hibiscus quinquelobus.

This plant is known in Sierra Leone as "Kowe" or "Corwey" in Mendi, and "Nassim" in Timani, and is sometimes referred to as "West African jute." Owing to the facility with which this fibre can be prepared, it has received special attention, and two Government agents are endeavouring to encourage its production. A small export trade in this fibre is being developed, but it is not possible that a large industry can be established unless the plant is systematically cultivated. Experiments on the cultivation of this species are now being conducted at Mabang.

The sample of fibre submitted to the Imperial Institute consisted of well-cleaned bast ribbons of fair strength. The length of the fibre varied from 3 feet to 7 feet 9 inches, most of it being about 5 feet long. The fibre was of a pale buff colour, of fair lustre, fine, and fairly soft. On chemical examination it yielded the following results:—

	Per cent.
Moisture	9·8
Ash	0·45
α-Hydrolysis (loss)	7·9
β-Hydrolysis (loss)	11·0
Acid purification (loss)	1·1
Cellulose	76·3
Length of ultimate fibre	1·0–3·2 mm. or 0·04–0·13 in.

On comparing these figures with those furnished by a sample of Indian jute of "extra fine" quality (see p. 3), it is evident that the "Corwey" fibre is of good quality, and resembles jute in its composition and behaviour.

The commercial experts to whom the sample was referred classed the material as a strong, bast-like fibre of good colour, and worth £25 to £26 per ton (June 1906).

Honckenya ficifolia.

Honckenya ficifolia grows abundantly in the swamps of the Sierra Leone Protectorate, and would yield a perpetual supply of stalks for retting if care were taken in cutting it. It is known by the various names of "Napunti" (Timani), "Potepo" (Mendi), and "Bolo-bolo" (Yoruba).

Attention was directed to the fibre of this plant as long ago as 1888, when a sample, accompanied by botanical specimens, was forwarded to the Colonial Office from Lagos to the Royal Gardens, Kew. The fibre was reported by commercial experts to belong to the jute class, to be superior to jute in strength, and to be readily saleable, and worth at that time £16 per ton (*Kew Bulletin*, 1889, 15).

The preparation of this fibre has recently been made the subject of investigation by Government agents in Sierra Leone, who have reported that considerable difficulty is experienced in separating the outer bark from the inner fibrous layer, and that this is particularly marked in the case of the older plants. Experiments are in progress with a view to ascertain whether the fibre can be more successfully extracted from young plants.

The sample of fibre forwarded to the Imperial Institute from Sierra Leone consisted of uncombed bast ribbons, which varied in length from 4 to 10 feet, the greater part being from 6 to 10 feet long. The fibre was well cleaned and prepared, but was of poor strength, and varied in colour from white to brown.

On chemical examination the material furnished the following results :—

	Per cent.
Moisture	9·6
Ash	0·3
α-Hydrolysis (loss)	6·0
β-Hydrolysis (loss)	9·7
Acid purification (loss)	0·4
Cellulose	78·3
Length of ultimate fibre	2·0–3·6 mm. or 0·08–0·14 in.

These figures show that the "Napunti" fibre closely resembles Indian jute in its chemical character, and is nearly as rich in cellulose as "extra fine" quality Indian jute (compare p. 3). It suffers a comparatively small loss on hydrolysis, and should consequently prove very resistant to the prolonged action of water.

The product was described by experts as a jute-like fibre of mixed colour ; value, about £20 per ton (June 1906).

Reference may be made here to a sample of this fibre ("Bolobolo" fibre) which was forwarded to the Imperial Institute from the Gold Coast in 1905. This product was much inferior to the material just described, owing chiefly to its having been very imperfectly cleaned. Commercial experts to whom it was submitted stated that it was weak and of very little value.

"Borfroko" or "Abala" Fibre.

As already stated, the plant yielding this fibre is at present unidentified. The sample submitted from Sierra Leone consisted of well-cleaned fibre which showed considerable variation in colour, texture, length, and general appearance. The colour ranged from white to reddish-brown, and whilst some of the

fibre was quite soft, other portions were harsh. The length varied from 10 inches to 6 feet, but most of the fibre was 3 feet to 3 feet 4 inches long. Chemical examination of the product furnished the following results:—

	Per cent.
Moisture	9·6
Ash	0·4
α-Hydrolysis (loss)	9·3
β-Hydrolysis (loss)	14·4
Acid purification (loss)	1·0
Cellulose	76·3
Length of ultimate fibre	1·0–3·6 mm. or 0·04–0·14 in.

These results show that the fibre is a member of the jute class, and resembles the "Napunti" and "Corwey" fibres so far as chemical behaviour and composition are concerned, although it loses more than these do on hydrolysis and is not quite so rich in cellulose as the "Napunti" fibre. It is, moreover, inferior to "Napunti" and "Corwey" fibres on account of its variation in colour, length, and texture.

The commercial experts reported that this was a rather short, mixed, bast fibre, part of the sample being weak; value, £17 to £18 per ton (June 1906).

The valuations given for these three fibres are based on the belief that it would be possible to utilise them as jute substitutes, but their value can only be determined definitely by technical trials on a manufacturing scale in comparison with jute.

Hibiscus esculentus.

Hibiscus esculentus is the well-known "Okra," "Awkraw," or "Bhindi" which yields a mucilaginous seed-pod used in many parts of the world as a vegetable, and appears to be grown in all parts of West Africa.

A sample of "Awkraw" fibre was forwarded to the Imperial Institute from Sierra Leone in 1905, and a description of the

product and the results of its examination were published in this *Bulletin* (1905, **3**. 256).

A second sample of the fibre, described as "Okra" fibre, was sent from Sierra Leone for further investigation in 1906. This sample was obtained from the plants after the second series of fruits had been gathered, in order to test the value of the fibre prepared at this particular stage. The fibre was mostly from 2 feet to 2 feet 8 inches long, but some short strands about 18 inches in length were also present. In general the product resembled the previous sample of "Awkraw" fibre, but was softer, whiter, and more lustrous, though only about two-thirds the length. The strength was uneven and poor. The quantity of the fibre supplied was insufficient for chemical examination.

Commercial experts to whom the sample was submitted described it as a brittle, jute-like fibre which, though of good colour, was mostly tender and weak. Its value was considered doubtful, but probably from £20 to £22 per ton. At the time of this valuation jute prices were much above the average, and, under ordinary conditions, this sample would not have been worth more than about £15 per ton. As the sample of fibre prepared from the older plants was valued at £18 to £20 per ton when prices were normal, it appears that in spite of the better appearance of the sample under consideration its value would be less on account of its inferior length and poor strength. It is, however, unsafe to draw a general conclusion as to the best period for the extraction of fibre from the plant from the examination of a single sample.

Urena lobata.

A short account of the fibre of *Urena lobata* has already been given in this *Bulletin* (1905, **3**. 262). The plant is known in West Africa as "Na fen fe" (Timani), "Subwe" (Mendi), and "Bolobolo" (Yoruba). Apparently some confusion exists with regard to the last name, which is said to be applied also to *Honckenya ficifolia*. *Urena lobata* occurs everywhere along the West African coast, but is extremely variable in the form of its leaves. Good specimens of fibre have been prepared in Sierra Leone, but the plant growing there does not form long, straight stems, and the fibre is therefore rather short.

In Northern Nigeria, *Urena sinuata* is grown by the road-sides, and is said to be cultivated to some extent in Bida (Nupe Province) for the manufacture of ropes, where it is known by the name of "Rama."

Among other plants yielding jute-like fibres which occur in West Africa may be mentioned a Malvaceous plant, known in Sherbro as "Papam," and a species of *Triumfetta*. Both of these are used locally in an undecorticated state for the manufacture of rough ropes.

The second part of this article dealing with West African fibres suitable for the manufacture of cordage, and with miscellaneous fibres, including flosses and silk cottons, will be published in the next number of this *Bulletin*.

OIL BEANS FROM SOUTHERN NIGERIA.

THIS consignment of the seeds of *Pentaclethra macrophylla*, commonly known as the "oil bean" or "owala bean" in Southern Nigeria, was forwarded to the Imperial Institute by the High Commissioner for the Protectorate, who desired to obtain definite information regarding the value of these beans as a source of oil.

Description of Sample.

The consignment weighed about 6 cwt., and consisted of large flattened beans covered with a hard brown testa (seed coat). They were from 1·5 to 2·75 inches in length, 1·2 to 1·8 inches in breadth, and 0·3 to 0·4 inch in thickness.

The kernels of the fresh beans should be white and soft, but in the present consignment a comparatively small proportion of the kernels were white, the bulk being brown or black, probably as the result of decomposition.

Chemical Examination.

A quantity of the oil present in the kernels was prepared and its principal constants determined. The residue left after

extraction of the oil from the kernels was analysed to ascertain its value as a feeding stuff.

The results of these investigations are as follows :—

	Per cent.
Proportion of hard seed coat in beans (by weight) .	20·7
Proportion of kernel in beans (by weight) . . .	79·3
Amount of oil contained in the whole beans . .	31·2
Amount of oil contained in the kernels (*i. e.* the beans freed from the seed coats)	39·00

It has been pointed out already that a large proportion of the kernels had become discoloured, and as this had probably affected the oil contained in them, it was considered advisable to prepare two specimens of oil, one from an average sample of the beans, and the other from a selected sample, consisting of beans with undecomposed kernels. The constants of the two specimens of oil so prepared are given in the following table :—

	Oil from beans with undecomposed kernels.	Oil from an average sample of beans.
Colour of oil . . .	Pale yellow	Yellowish-brown
Odour of oil . . .	Slightly pungent	Pungent
Specific gravity at 100° C.	0·8637	0·8627
Solidifying point . .	8° C.	5° C.
Saponification value[1] .	185	182
Acid value[1] . . .	4·6	10·0
Iodine value . . .	94·3 *per cent.*	94·4 *per cent.*
Hehner value . .	94·2 ,,	95·7 ,,
Unsaponifiable matter .	—	0·27 ,,
Melting point of fatty acids	52·4° C.	53·4° C.

It will be seen that the oil from the average sample of beans was darker in colour, more pungent, and possessed a higher acid value (*i. e.* was more rancid) than that prepared from the selected beans.

The oil does not "dry" when exposed to the air, even at temperatures slightly above the atmospheric, and this observation is in agreement with the low iodine value which classes it amongst the non-drying oils, of which olive oil is the best-known type. It possesses an unpleasant pungent odour (even when

[1] Milligrams of potash required per gram of oil.

prepared from undecomposed kernels), which is not removed by any of the simple processes in general use for refining oils. On standing for some time it slowly deposits a quantity of solid fat.

Technical Trials and Commercial Valuation.

The chemical examination having indicated that this oil might be suitable for the manufacture of soap, a portion of the consignment of beans was submitted to a firm of soap manufacturers, who kindly undertook to extract the oil and make a trial of it as a soap-making material. Considerable difficulty was experienced in preparing the oil for this technical trial; in particular, it was found necessary to decorticate the beans before extracting the oil, in order to avoid inclusion of the brown colouring matter of the hard seed coat.

The firm of soap makers reported on the oil as follows:—

"The oil obtained from the decorticated seeds was much lighter than that prepared from the undecorticated seeds; it contained comparatively little albuminous matter, but possessed a pungent odour. Its constants were:—

Iodine value	87·07 *per cent.*
Acid value	14·3 [1]
Melting point of fatty acids . .	50·15° C.

The oil, despite the high melting point of its fatty acids, yields a rather soft soap. As this soap is inferior in colour, is somewhat softer, and has a far stronger odour than that from cotton-seed oil, we have no hesitation in putting its value at £3 per ton below this oil" (refined cotton-seed oil is, at present, worth from £24 to £26 per ton).

Analysis of the Meal.

For this purpose the meal left after the extraction of the oil from the selected beans containing undecomposed kernels was used. It gave the following results:—

	Per cent.
Moisture	12·9
Ash	3·5 [2]

[1] Milligrams of potash required per gram of oil.

[2] Containing 22·6 per cent. of phosphoric acid (calculated as P_2O_5), and equivalent to 0·55 per cent. of phosphoric acid (calculated as P_2O_5) in the meal.

	Per cent.
Proteids	34·8
Fibre	6·6
Sugar (dextrose)	8·2
Carbohydrates (other than sugar)	33·7

These figures indicate that this meal possesses a high nutritive value, and compares favourably in this respect with the feeding-cakes prepared from linseed, cotton seed and other similar materials. No analysis of the meal left after the extraction of the oil from the unselected beans was made because this material was very dark coloured and possessed an unpleasant odour, which would prevent its use as a cattle food. Such material could probably only be used as an organic manure.

It is impossible to say definitely what the commercial value of feeding-cake prepared from the beans with undecomposed kernels would be, since the amount of such material obtainable from this consignment was so small that no cake could be prepared, and no feeding trials with animals could be carried out, but it is probable that it would be worth as much as cotton-seed cake, viz. from £4 to £5 per ton, but feeding trials would have to be made before the material could be recommended for this purpose.

General Conclusions and Recommendations.

In drawing conclusions as to the commercial prospects of the oil beans of *Pentaclethra macrophylla* from the results of the chemical examination and technical trial, it should be borne in mind that, as already indicated, the consignment of beans sent to the Imperial Institute was not in a fresh condition, and that the decomposition which had taken place in the kernels of the bulk of the beans had no doubt to some extent adversely affected the oil, and to this circumstance was no doubt due in part the dark colour and objectionable odour referred to by the firm of soap makers, and it is possible that if the consignment of beans had been fresh a more favourable view of the technical possibilities of the oil might have been taken.

The results of the chemical examination of the oils derived respectively from undecomposed kernels and from an average sample of kernels (see p. 11) show, however, that the chemical

nature of the oil has undergone but little change as the result of the decomposition of the kernels. Consequently the softness of the soap produced is probably a constant feature, and therefore the price obtainable for it, even when made from fresh kernels, will no doubt always be less than that paid for cotton-seed oil, which yields a harder soap.

From the fresh beans, as already indicated, there is the possibility of preparing a feeding-cake, which would to some extent add to their value, and, taking this into account, they would probably be worth from £5 to £5 10*s.* per ton in this country.

It appears that small consignments of these beans have from time to time during recent years been placed on the Antwerp market from the Congo Free State. They have met with a slow sale, usually at prices equivalent to about £5 per ton, and it is stated that this price has proved unremunerative to exporters, and that the trade has almost if not entirely ceased.

In conclusion, it appears unlikely that there will be in the near future either a large or profitable market for these beans, and though it might be worth while if the beans are available in large quantities to ship them on the chance of securing a small return, especially when, as at present, all oil seeds are fetching abnormally high prices, it would not be advisable to encourage the natives to cultivate *Pentaclethra macrophylla* for the sake of exporting the beans.

LATEX AND RUBBER OF *PARAMERIA GLANDULIFERA* FROM INDIA.

Parameria glandulifera is a climbing plant, distributed through Southern Burma, Indo-China, and the Malay Peninsula, which has long been known to yield good rubber, and is, in fact, exploited for this product by the native collectors. Samples of the latex and rubber of this plant have been forwarded to the Imperial Institute from Burma and the Andaman Islands respectively, and the results of their examination may be recorded here.

The latex was a milky fluid possessing a slightly sour odour. It had undergone partial coagulation during transit with the production of a cake of rubber, which after drying was found to weigh 45 grams, whilst the residual latex, measuring 400 c.c., still furnished 8 per cent. of dry rubber. The total amount of dry rubber obtained from the sample was therefore 77 grams, which represents a yield of about 19 per cent. from the latex.

The latex was partially coagulated on boiling or by heating in boiling water. The addition of a small quantity of a mineral acid, dilute sulphuric or hydrochloric, caused complete coagulation at once in the cold, the rubber separating and leaving a slightly turbid liquid ; alcohol produced a similar result. Acetic acid had little effect in the cold, but coagulation was readily induced when the acidified latex was gently warmed. The addition of sodium sulphate, magnesium sulphate, or sodium chloride caused the latex to cream completely on standing, the rubber particles separating and forming a distinct layer on the surface without coalescing, but on removing the liquid by straining, the particles aggregated to form a clot of rubber. It may be mentioned that the fresh latex of this plant collected in French Cochin-China by M. Pierre was found to be readily coagulated by gentle heat even after dilution with water.

The rubber obtained from the latex had a light brown colour after drying, was free from stickiness, and exhibited very good elasticity and tenacity. From its physical characters it appeared to be of good quality.

The results of the chemical examination of the dry rubber are given in the following table :—

	Per cent.
Caoutchouc . . .	91·8
Resin	6·3
Proteids	1·4
Ash	0·5

These figures confirm the opinion of the quality of the rubber which was based on its physical properties.

Parameria glandulifera is very common in the forests of the Andamans, but the exploitation of the vine for its rubber is stated to present some difficulty.

The sample of rubber forwarded to the Imperial Institute had, unfortunately, undergone deterioration during transit, and on arrival in this country its physical condition was unsatisfactory. It consisted of 15½ lb. of rubber in balls, which ranged from 2 to 3 inches in diameter. The balls were almost black externally, but whitish and fairly moist within when freshly cut; they were exceedingly sticky on the outside, and showed signs of considerable over-heating. The rubber from the centres of the balls was almost free from stickiness, and exhibited very good elasticity and tenacity.

The chemical examination furnished the following percentage results:—

	Sample as received.	Dry material.
Moisture	15·3	—
Caoutchouc	77·6	91·6
Resin	4·9	5·8
Proteids	1·6	1·9
Ash	0·6	0·7

It will be seen that the sample of the rubber of *Parameria glandulifera* from the Andamans is of very good quality so far as chemical composition is concerned, and corresponds closely with the product prepared from the latex received from Burma. The percentages of resin and proteids are low, and the rubber is free from vegetable impurities.

The investigation of these samples has shown that the rubber furnished by *Parameria glandulifera* is of good quality, judged by its chemical composition, and there is no doubt that, if carefully prepared, the product would realise satisfactory prices in the market.

COPAL RESIN FROM THE GOLD COAST.

THREE samples of copal resin from Ashanti were forwarded to the Imperial Institute by the Superintendent of Agriculture for the West African Colonies and Protectorates. These have been examined chemically at the Imperial Institute and submitted to experts for valuation, with the following results:—

Description of Samples.

Sample No. 1, labelled "Dead tree copal, Obassi, Ashanti," consisted of a single cake of resin weighing about 3 lb. The cake was dark coloured externally, but the bulk of the resin had a yellow colour, thin sections being almost colourless and quite transparent. The resin had a slight aromatic odour, but no taste; it exhibited a conchoidal fracture, and was readily powdered.

Sample No. 2, labelled "Gum copal from Eikona, Ashanti, said to occur plentifully, but no demand for it in Kumassi," weighed about $1\frac{1}{2}$ lb., and consisted of two varieties of resin, which differed considerably in appearance.

(*a*) was a clear, light yellow resin of similar character to sample No. 1 from Obassi; it was quite transparent and devoid of taste.

(*b*) was translucent, of light buff colour, and possessed a slight odour; occasional white opalescent patches occurred throughout the lump.

Both portions were free from enclosed foreign matter.

Sample No. 3, labelled "Gum copal from Oboamang, Ashanti, said to occur in some quantity in the forests, but not saleable in Kumassi," consisted of several lumps of resin, which together weighed about 1 lb. The lumps varied in appearance, the majority being made up of several masses of clear or cloudy yellow resin interspersed with thin layers of foreign matter. Some of the outer cavities of the lumps were partly filled with a resin of much brighter yellow colour than the general mass.

One large lump included in this sample was much superior in quality to the remainder, being light yellow, translucent, and free from enclosed foreign matter.

Results of Examination.

The results obtained in the chemical examination of the three samples are in general agreement with the figures previously recorded for West African copal.

The samples were only partially soluble in alcohol, benzene, carbon disulphide, chloroform, ether, or turpentine oil, but were

completely dissolved by mixtures of benzene and alcohol, turpentine oil and alcohol, or benzene and ether.

Commercial Valuation.

The resins were submitted to brokers for commercial valuation, and the following quotations were obtained: No. 1, 60*s.* per cwt.; No. 2, 50*s.* per cwt.; No. 3, 30*s.* per cwt.

Sample No. 1 was also sent to a firm of manufacturers, who valued it at a much lower price than the brokers, viz. 45*s.* to 47*s.* 6*d.* per cwt.

It was stated that consignments similar to these samples could be sold without difficulty, as there is a good demand for copals of this class.

The manufacturers pointed out that moderate quantities of copal from the Gold Coast were formerly received in this country, but, owing to the diminution of the supplies, varnish makers turned their attention to other varieties of copal, which can be regularly obtained in large quantities. Accra copal, the name by which the Gold Coast resin is known in the market, has so far never been held in very high favour, in consequence, it is thought, of the unsatisfactory way in which it has been shipped. The resin is usually sent in the rough state, with a large quantity of dust and dirt mixed with it, no attempt being made to separate the different qualities. Its value is thus considerably diminished.

On the other hand, Congo copals, which are now largely used, are more or less graded for colour and sometimes for size. In addition, the dust and dirt are carefully removed, and many of the consignments are roughly washed. As a result of this treatment some of the clean sorted Congo copals realise from £120 to £150 per ton.

There appears to be no reason why Gold Coast copal, if carefully cleaned and graded before shipment, should not realise satisfactory prices in the market.

In grading, the copal is separated according to size and colour. The highest prices are obtained for the pale, translucent resin in large and uniform pieces; the darker or cloudy pieces realise less, whilst the dust and chips fetch the lowest prices.

The most important point is to secure uniformity in shipments, so that manufacturers can be sure that successive consignments of the resin, if treated in the same way, will yield a similar product.

The copal would realise a higher price if it were "washed" before shipment. This is usually done by scraping off the outer covering of dirt, dipping the scraped resin into a dilute alkaline solution, then into clean water, and finally drying.

Further information is required regarding the origin of Accra copal. Some of the resin is apparently found in a fossilised or semi-fossilised condition, but at least a portion of it is stated to be derived from living trees. Information is being obtained as to the botanical identity of the latter.

YEBB NUTS FROM SOMALILAND.

A SAMPLE of these nuts, weighing 18 lb., was forwarded to the Imperial Institute by the Commissioner of the Somaliland Protectorate, in order that their nutritive value could be determined.

These nuts are of special interest, as they have formed the principal food of the Somalis during the famines induced by the severe droughts which have prevailed in Somaliland during recent years.

It has not been possible to ascertain the botanical origin of the nuts, as no herbarium specimens of the tree have yet been forwarded, and the nuts are unknown here. A second sample was received subsequently from the Commissioner, and, as these showed signs of vitality, specimens were sent to Kew, where an attempt is being made to raise plants for the purpose of identification.

The kernels of most of the nuts of the first consignment were found to be decomposed, and when cut open presented a black appearance, whereas the good kernels were white or yellow.

An analysis of the selected kernels gave the following results :—

		Per cent.
Moisture		9·3
Ash		3·1
Sugars	Reducing	2·3
	Cane	21·6
Carbohydrates (other than sugars); by difference		37·1
Proteids	Albuminoids	11·8
	Amides	1·3
Fibre		2·7
Oil		10·8
Nutrient ratio		1 : 6·5
Nutrient value		92

The nuts were tested for alkaloids and glucosides, but no indication of the presence of such constituents was obtained.

The results of the analysis indicate that the nuts are likely to prove a useful food-stuff. A satisfactory point is the presence of considerable quantities of sugars and oil in addition to the carbohydrates.

Judging from the analytical figures alone, the nutrient ratio, *i. e.* the ratio of albuminoids to carbohydrates and oil converted into their starch equivalents, is a very serviceable one, and the total "nutrient value" is high. The kernels are rather tough, and this point raises some doubt as to the complete digestibility of the carbohydrates other than sugars.

In preparing the nuts for use as food, it is desirable that they should be soaked in just such a quantity of water as they can absorb, since if more be used there is danger of loss of the sugars, which would diffuse into the excess of water.

KOLA SEEDS FROM THE GOLD COAST.

THESE samples of kola seeds, commonly known as "kola nuts," were included in a collection of products forwarded for examination to the Imperial Institute by the Director of Agriculture in the Gold Coast.

Two varieties of seeds, white and red, were submitted for

analysis, and both fresh and dried specimens of each were supplied. It was stated that the Hausas, who are the largest purchasers of these seeds, prefer the white to the red variety, and also believe that they lose a large proportion of their tonic properties when dried. It was therefore desired to have comparative analyses made of the white and red seeds in the fresh and dried condition, in order to determine whether there is any support for the native opinion.

Description of Samples.

The samples were collected in East Akim, and were as follows:—

VI. "Fresh white kola seeds." This sample, weighing 210 grams, consisted of eleven seeds of the size of large chestnuts. They were packed in charcoal, and appeared to be quite fresh on arrival. The seeds had a pale straw colour, but the freshly-cut surface rapidly turned brown.

VII. "Fresh red kola seeds." Twelve seeds, the total weight of which was 290 grams, were supplied. The seeds were the size of chestnuts, and were carmine externally and pink internally. On cutting the seed, the exposed surface soon turned brown.

VIII. "Kola seeds, dry, white." This sample consisted of fourteen seeds, weighing 72 grams. They were very hard and of a dark reddish-brown colour.

IX. "Kola seeds, dry, red." There were nine whole seeds and ten pieces, weighing in all 87 grams. They were very hard, and of a reddish-brown colour.

Results of Examination.

The percentage of moisture and of total alkaloids in the kola seeds were determined, with the following results:—

	Moisture.	Total alkaloids, principally caffeine.	
		Calculated on original substance.	Calculated on water-free substance.
	Per cent.	*Per cent.*	*Per cent.*
Fresh seeds, white	67·7	0·76	2·36
,, ,, red	55·9	0·88	2·00
Dry seeds, white	11·8	2·19	2·48
,, ,, red	15·6	1·97	2·33

Commercial Valuation.

Samples of the dry seeds were submitted to commercial experts, who reported that they were rather small and in a musty condition. Most of the seeds were whole, whereas buyers in this country prefer them split. It was thought that kola seeds of the quality of the samples might realise $1\frac{1}{2}d.$ per lb. in London, but the current value of good qualities is $2\frac{1}{4}d.$ to $2\frac{1}{2}d.$ per lb. The experts stated that the colour does not appear to make any difference, as white and red seeds sell equally well here, and if there is any preference at all it is in favour of the red variety.

The results of the chemical examination show that there is little difference in the amount of caffeine present in the white and red seeds, although in these four samples the white seeds have a slight advantage in this respect. It would, however, be unsafe to conclude, without further analyses, that the white seeds contain as a rule more caffeine than the red.

The results of the present investigation do not support the view that the seeds deteriorate on drying, as the proportion of caffeine calculated on the dry material is a little higher in the dry than in the fresh seeds, though no doubt the latter are more agreeable for chewing as a condiment.

COCOA FROM UGANDA.

THIS sample of cocoa, grown in the Botanic Garden at Entebbe, was received at the Imperial Institute from the Acting Deputy Commissioner for Uganda. It was described as having been "cured by rough-and-ready methods," and a request was made for a report on its quality and commercial value.

The sample, which weighed 4 lb., consisted of apparently unwashed and unpolished beans, varying in colour from pale dull pink to dark brownish-red. Traces of the saccharine pulp were in most cases still adhering to the beans. The latter were of medium size and rather shrivelled; they broke fairly readily, and the fractured surface was dark and slightly purple, indicating that the beans had not been fully fermented. The taste

was much milder than that of West Indian cocoa, so that the incompletely-fermented condition was less important than would otherwise have been the case.

The cocoa was submitted to a firm of brokers, who stated that it was "of good appearance, reddish skin, but poor 'break,' rather dark and slaty." It was valued at *76s.* per cwt. in London, thus showing that it would take about the same rank as good quality Ceylon and second grades of Jamaica and St. Lucian cocoas. Consignments of similar character would probably find a very good market.

This experimental cultivation of cocoa in Uganda has thus given very promising results, and the matter deserves further attention in the Protectorate.

GINGER FROM SIERRA LEONE.

THESE samples of ginger were forwarded to the Imperial Institute for examination by the Colonial Secretary of Sierra Leone.

One sample (*a*), consisting of half a hundredweight of ginger, was purchased from a trader just previous to shipment, and was stated to represent the product as generally prepared in Sierra Leone. The other sample (*b*) consisted of the same quantity of dried ginger specially prepared by Mr. Abayomi Cole.

It was desired to ascertain the comparative value of the two samples, in order to determine whether the preparation of ginger by the improved method should be encouraged in the Colony.

The first sample (*a*) was dirty brown in colour and rather mouldy; it was untrimmed and undecorticated. The aroma was strong and the taste pungent, but a distinctly mouldy odour was also noticeable.

The ginger prepared by Mr. Cole's method was much cleaner and had a fair aroma, but, like the first sample, it was not trimmed or decorticated.

In both cases the roots were flatter and thinner than the best qualities of ginger which appear on the English market.

The samples were submitted to commercial experts in Liverpool and in London.

The former stated that there is always a demand for the class of ginger represented by these samples. They valued the sample (*a*) at 20*s.* per cwt., and sample (*b*), prepared by the improved process, at 24*s.* per cwt. They pointed out, however, that both samples contain many small pieces, and stated that if larger pieces could be obtained the value would be about 4*s.* per cwt. higher in each case, as the larger pieces could be sold as whole ginger.

The London firm to whom the samples were submitted described (*a*) as ordinary West African ginger, worth about 18*s.* to 20*s.* per cwt. The second sample (*b*) was considered to be a great improvement on the preceding specimen, and was valued by them at 28*s.* to 30*s.* per cwt.

Although the valuations given above differ in some degree it is clear that the ginger prepared by Mr. Cole's method is distinctly superior in value to that generally produced in Sierra Leone. It seems desirable, therefore, that the preparation of ginger by this new process should be encouraged in the Colony, and that consignments of the improved product should be placed upon the market, so that its value can be accurately determined.

GENERAL NOTICES RESPECTING ECONOMIC PRODUCTS AND THEIR DEVELOPMENT.

SANSEVIERIA AND AGAVE FIBRES IN EAST AFRICA.

Sansevieria Fibre.

SEVERAL species of Sansevieria, the "bowstring hemp" plant, grow wild over very extensive areas in East Africa. These plants yield valuable fibres which are now being prepared on a commercial scale, and are employed for the manufacture of cordage. An account of an investigation at the Imperial

Institute of the quality, chemical composition, and value of some of these products has already been given (*Bulletin of the Imperial Institute*, 1906, **4**. 189).

The exploitation of Sansevieria fibres in British East Africa is being carried on chiefly by the Afro-American Trading and Navigation Company, and an interesting account of their work has been given recently by Herr Richard Sorge in *Der Tropenpflanzer*, 1906, **10**. 584.

The Afro-American Company has obtained concessions from the Government of 105 square miles in the neighbourhood of Voi, and 50 square miles on the Tana River, which is about 12½ miles distant from Voi. They have established a factory for extracting the fibre at Voi itself, which is situated on the Uganda Railway at a distance of 103 miles from Mombasa, and at an elevation of 1,900 feet above the sea. The factory is close to the railway, and is also near the Voi River, so that there is an ample supply of water available for washing the fibre and for the engines. On the Tana River concession there is a waterfall of over 300 feet, which might be utilised as a source of power for driving electrical plant.

The factory at Voi is situated at the lowest point on the whole concession, a circumstance which is of considerable importance in relation to the transport of the leaves, since the natural slope of the land enables the leaves, when loaded in light trucks, to be carried down by their own weight from the bush to the factory, and only the empty trucks have to ascend the incline. For this purpose the Company has constructed a narrow railway of two-feet gauge, which at present runs for a distance of about six miles. No locomotives are used on the railway, but the trucks are pushed up by hand.

In the district of Voi the Sansevieria plant grows on a firm, loamy, lateritic soil in a remarkable primeval jungle, which is characterised by spiny cactus-like euphorbias and thorny acacia trees. Between these plants appear the thick, fleshy leaves, five feet or more high, of the two species, *Sansevieria Ehrenbergii* and *S. cylindrica* (or *S. sulcata*).

The Sansevieria plant grows very rapidly in this jungle or thicket; it requires no attention, and necessitates no labour beyond that involved in the cutting and harvesting of the

leaves. Multiplication takes place to an almost unlimited extent, since the roots throw out suckers which rapidly become plants with leaves ready for cutting, and these in turn furnish a fresh supply of suckers. The plant requires shade for its growth and development, and is thus well adapted to the jungle.

The work of collecting the leaves and extracting the fibre is carried on all the year round except for interruptions caused by excessive rain or by mishaps to the machines. Allowing for such intervals, the whole time during which work is carried on in any one year does not amount to more than nine months.

The cutting of the leaves is not an easy task, as the jungle is thorny and spiny, and during the rainy season it swarms with mosquitoes and other noxious insects. The daily task of each worker is to cut 1,200 leaves and bind them in bundles of fifty. A second gang of labourers load these leaves in the railway trucks, convey them to the factory, and unload them in the proximity of the fibre-extracting machine. A third gang, consisting of the older men, together with women and children, split the leaves longitudinally into two pieces. Other workers carry the split leaves to the table of the extracting machine. The machine strips the epidermis from the leaves and crushes them in such a manner that the sap and most of the soft tissue are removed from the fibre. The fibre, after leaving the machine, is thrown into water and moved about by hand in order to free it from sap and adhering pulpy matter; if this washing is not carefully carried out there is a danger that portions of the epidermis may cling to the fibre and give it a green colour, and also that some of the gummy matters of the leaf may remain and cause the strands of fibre to adhere to one another; these defects cause a considerable reduction in the market value of the fibre. The clean fibre is hung on wires and exposed to the sun for a day or two, whereby its colour and lustre are considerably improved. The bundles of dry fibre are then submitted to the action of a brushing machine, with the result that any remaining fragments of pulp are removed and the individual strands of fibre are rendered smooth and parallel to one another. Finally, the fibre is pressed into bales, each weighing about 400 lb.

The extracting machine in use at the Voi factory is that

known as "La Estrella" (Prieto Patent), a pattern which is employed in Mexico for the preparation of sisal hemp. It was obtained from Mexico at a price of about £550; the cost at Voi, including the expenses of transport and erection, amounted to about £750. The machine requires 10 h.p. to drive it, and treats daily 120,000 leaves, with the production of about half a ton of fibre.

Since the machine is capable of dealing with 120,000 leaves per day, this number must, of course, be cut, split, and delivered to the factory, and this determines the daily task for all branches of the work. Just as many workers are employed, therefore, for cutting the leaves, for conveying them to the factory, and for splitting them, as can deal with this quantity of material in seven hours. The workers are not, however, actually engaged to work for seven hours, but to cut, split, or deliver 120,000 leaves per day, and after the completion of their daily task they are free. The different gangs always endeavour among themselves to maintain this supply, and in this way a spirit of emulation is created, which is of great advantage to the progress of the work. The workers receive, on the average, six rupees (eight shillings) per month, in addition to full board and quarters near the factory. This system has succeeded admirably, and the Company has experienced no difficulty in obtaining the necessary labour.

The Afro-American Company is now employing a second machine, known as the "Corona" (Boeken Patent), which costs about the same amount as that previously mentioned, and treats about the same number of leaves per day, but has the advantage of being able to strip longer leaves and of leaving very little fibre in the waste residue.

It has been found that 100 Sansevieria leaves weigh, on the average, 60 lb., whence it follows that 120,000 leaves weigh about 72,000 lb. The latter yield one ton of fibre, or 3·1 per cent. Thus, in order to obtain 3·1 lb. of fibre, it is necessary to transport 310 lb. of leaves to the factory, and this adds very largely to the cost of production. A great deal of consideration has been given to this question of transport. It has been suggested that a fibre machine should be constructed in combination with a locomotive, which could be driven to the

place where the leaves are being cut, and would enable the extraction of the fibre to be carried out on the spot. Such a combination, however, would be unwieldy and complicated, could not be run on a narrow-gauge railway such as that at present being used, and could not possibly be run on wheels without rails, as in the wet weather it would sink in the soft ground and become immovable.

A more feasible plan, however, has been proposed, which consists in the use of a simple crushing machine composed of two rollers rotating in opposite directions. The machine would be combined with a motor, and would be capable of being conveyed to the plantation on the ordinary rails. By this means the sap could be squeezed out, and the weight of the leaves would thereby be very much reduced. It seems probable, however, that in this case the crushed leaves would require to be treated at the factory within a few hours, as otherwise fermentation might occur and cause considerable injury to the fibre.

In German East Africa there are large areas of Sansevieria plants in the neighbourhood of Kilimanjaro, and also at Ikoma, which lies to the west between Kilimanjaro and the Victoria Nyanza. The plant also occurs in the Wilhelmstal District, and is being treated on a small scale at Gombara; other large areas occur at Mkomasi. All these places will be made accessible by the extension of the Usambara Railway. Up to the present, however, Sansevieria fibre has not become an article of export from German East Africa.

Agave or Sisal Fibre.

Accounts of the cultivation, extraction, and commercial exploitation of sisal hemp (*Agave rigida*) in Mexico and in India have been given in this *Bulletin* (1903, **1.** 201, and 1904, **2.** 260).

The sisal hemp plant is well adapted to many parts of East Africa, and is being cultivated with considerable success on German territory. The first attempts to establish the cultivation of Agave plants in German East Africa were made in 1893. The results obtained have shown that the soil and climate are exceedingly favourable; the fibre is now being produced on a commercial scale.

A consignment of bulbils of *Agave rigida*, var. *sisalana*, was sent from Florida to Kikogwe in 1893, but only a small proportion could be used for planting. In 1898 the first cutting of the leaves was made, and at that time the plantation contained 63,000 plants. Machinery for the preparation of the fibre was introduced in 1899, and in 1904 the plantation at Kikogwe and the neighbouring one at Muera together covered 3,460 acres, and contained 1,800,000 plants. Plantations have also been established at many other places in German East Africa. The industry is making rapid progress, and it is anticipated that in a few years the quantity of sisal hemp produced will amount to at least 10,000 tons, of value £350,000 to £400,000 per annum.

The rate of increase in the quantity of the fibre produced in German East Africa is shown by the following figures, which represent the amounts exported in 1901–05: In 1901, 202 tons; in 1902, 353 tons; in 1903, 417 tons; in 1904, 756 tons; and in 1905 about 1,300 tons were exported, of the value of £50,000.

There appears to be no doubt that the sisal hemp plant would also repay cultivation in British East Africa. It is considered by the Department of Agriculture at Nairobi that the coast lands are the most favourable places in the Protectorate for this purpose, although it is very probable that the plains in the neighbourhood of the Athi River and lower down the country would also be satisfactory.

A plot of *Agave rigida* var. *sisalana* has been planted at the Government farm at Nairobi, and is being carefully watched. The sisal plant grows more slowly at Nairobi than it does in the coast districts, but whereas the plant usually dies at the end of the fifth year at the coast, it will probably live for eight or ten years in the vicinity of Nairobi. The question of the length of life of the plant is not, however, of much importance, since, according to the method adopted in German East Africa, fresh suckers are planted between the rows of the old plants after the third year. The district of Gasi is regarded as well adapted to the industry, since the soil is of the same sandy nature as that of the German plantations, the rainfall is abundant, and both fuel and water are available. The neigh-

bourhood of the Government Experiment Station at Mazeras is also considered to be very suitable.

The sisal hemp plant has also been found to grow well in certain parts of Uganda.

Samples of sisal hemp from British East Africa, German East Africa, and from Uganda have been received at the Imperial Institute, and have been found to be of good quality and value.

In considering the relative merits of the native Sansevieria fibres on the one hand, and of sisal hemp on the other, with a view to exploitation, the following points present themselves :—

1. It has been stated already that the Sansevieria plant propagates itself rapidly by throwing out suckers, and requires no attention. In this respect it has a great advantage over the sisal Agave, which must be planted out and carefully cultivated.

2. The Sansevieria plants grow well in the shade, whilst sisal plants need much light for their growth and development, and therefore require that the ground should be kept cleared.

3. The harvesting of the Sansevieria leaves can be carried out or postponed at will, and the plants may be left for a year or more without injury or loss. The leaves of the sisal Agave, on the contrary, must be cut at a particular time, or otherwise the plant will develop a huge inflorescence or "pole," and, after flowering, will die.

4. The leaves of Sansevieria can be stored for some time before the fibre is extracted, but sisal leaves must be treated immediately after they have been cut.

All the features mentioned above are in favour of the Sansevieria industry. The following points, however, show that in certain respects sisal hemp possesses considerable advantages.

5. The yield of fibre from the fresh leaves of *Agave rigida* var. *sisalana* amounts to about 4 to 4½ per cent., whilst the yield from the leaves of *Sansevieria Ehrenbergii* or *S. cylindrica* is only about 3 per cent.

6. Sisal hemp is superior in quality to the fibre of the species of Sansevieria above mentioned, and is consequently of higher commercial value. Sisal hemp of good quality is worth about £35 to £40 per ton, whilst the fibre of the Sansevierias is only worth about £28 to £30 per ton in the London market.

It is by no means certain, therefore, that the cultivation of

sisal hemp would not prove more remunerative than the exploitation of the wild Sansevierias, although much more labour is involved in connection with the former than with the latter.

In conclusion, it should be pointed out that the remarks made with respect to Sansevieria are only applicable to the species mentioned, and do not refer to *Sansevieria guineensis*, which yields a better fibre, and, although found in East Africa, has not hitherto been commercially exploited in that country. This species, however, is receiving attention in West Africa, and will be dealt with in a future article.

COTTON GROWING IN SPAIN.

THE vigorous action which has been taken by the British Cotton Growing Association and by similar associations in France, Germany, Belgium, Portugal, and Italy, to obtain new sources of supply of raw cotton by the establishment of cotton growing in their respective Colonies, has stimulated Spanish cotton spinners and manufacturers to turn their attention to the possibility of advancing the cultivation in Spain. As an outcome of their consideration of this question, experiments have been conducted in certain regions of South Spain which possess favourable conditions of soil and climate. A paper giving a description of the meteorological conditions of these districts, and an account of the progress and results of the experiments, was read by Señor Don E. Calvet at the Third International Congress of Delegated Representatives of Master Cotton Spinners' and Manufacturers' Associations, which was held at Bremen in June 1906.

Cotton is said to have been introduced into Spain by the Arabs, and, in the eighth century, was grown by them on the plains of Valencia. The cotton thus produced was spun in Cordova, Sevilla, and Granada, and, at a later date, in Catalonia. In the last-mentioned Province the cotton industry underwent a great extension in the thirteenth century, receiving its raw material, as in the days of the Arabs, from the southern parts of the Iberian Peninsula. The cultivation of cotton, however, did not keep pace with the growth of the textile industries, but

gradually decreased after the expulsion of the Moors in 1609. This occurrence in the history of Spain dealt a great blow to the general agricultural prosperity of the country. The Moors had established a system of irrigation by means of which the fertility of the soil was greatly increased, and in their hands the Province of Valencia had become a model of agricultural practice for the rest of Europe.

In the eighteenth century the Catalonians were faced with the problem of obtaining sufficient raw material for their industry, and therefore made great efforts to encourage cotton cultivation in Andalusia. As a result of their endeavours, a crop of 8,000 to 10,000 bales per annum was obtained on the plains of Motril during the American war of secession.

Later, even though the Spanish Government imposed protective duties, the cotton-growing industry gradually declined. This was due to several causes, of which the chief were the competition of American cotton, the disinclination of the Andalusian farmers to improve their methods of cultivation and introduce agricultural machinery, the degeneration of the cotton plant, and the facility with which sugar-cane culture could be substituted for that of cotton.

Evidence as to the suitability of Andalusia for cotton growing is furnished by the climatic data which are given in the following tables. The corresponding temperatures for the cotton districts of the United States of America are added for comparison.

Average temperature in the open during the period of vegetation of the cotton plant.

	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
U.S.A. Northern District .	61·0	69·2	76·7	79·5	77·3	71·3	61·8	49·6
,, Central District .	63·2	70·8	77·9	80·9	79·6	74·4	65·2	55·6
,, Southern District .	69·7	75·4	81·3	83·3	82·1	78·2	70·3	61·5
Jerez de la Frontera (Andalusia) . .	63·5	65·5	72·1	79·0	80·2	74·7	68·2	59·7

Average rainfall in Jerez de la Frontera (1899–1903).

April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.
2·6	1·6	1·0	0·2	0·2	1·2	4·0	3·9

These figures show that the rainfall is not so favourable as could be wished. There is not much rain in the spring months, whilst in the summer there is scarcely any. In consequence of this drought, which is quite typical of this southern region of Spain, the cotton plants wither and die, and experiments, to which reference is made later, have demonstrated that cotton cannot be grown advantageously unless the plants are occasionally watered during the summer. In this connection it may be mentioned that at the beginning of the nineteenth century, when cotton cultivation prospered in Andalusia, it was only carried on on the irrigated plains of Motril. The area which could be devoted to cotton is much restricted, as, unfortunately, irrigation is but little practised in Spain, and in the gardens of Valencia, Jatiba, Murcia, and Almeria the irrigated lands are covered with trees and vegetables, which are more remunerative than cotton.

Nevertheless, Andalusia possesses thousands of acres of land, at present used as pasture land for the cattle (principally bulls for the bull-fights), which could easily be irrigated and used for cotton growing. It is considered that very satisfactory results could be obtained in this way, and that the whole of the land along the banks of the Guadalquivir, from Andujar to Huelva, could be devoted to cotton, and would furnish an annual crop of at least 150,000 bales.

In order to encourage cotton growing in Spain, a law has been passed recently which enacts that the taxes are to be remitted for the first three years on lands used for cotton cultivation, and that for a further period of ten years these lands shall not be required to pay a higher tax than was levied on them before cotton growing was started. This law also provides for Government prizes to the amount of 50,000 pesetas (about £2,000) for the first year, 100,000 pesetas (about £4,000) for the second year, and 250,000 pesetas (about £10,000) for the third year, such prizes to be awarded to the farmers who have grown cotton in the largest quantity and of the best quality.

Experiments have been carried out at official establishments on both irrigated and non-irrigated land. With regard to the latter, although some varieties of cotton are capable of resisting drought to a considerable extent, yet the cultivation on non-irrigated land is not generally possible in Spain on account of

the lack of rain and the severity of the dry south winds. There are, however, a few localities near the sea where sufficient moisture is available to maintain the plant during the period of drought.

The most complete experiments were those conducted on a small scale at the agricultural station of Jerez de la Frontera.

The experiment on non-irrigated land was undertaken on an area of about 0·15 acre, possessing a soil which, when dried, had the following percentage composition: Nitrogen, 0·0754; phosphoric acid, 0·1070; potash, 0·290; lime, 0·1876; organic matter, 0·592. The land was twice prepared in a suitable manner, and the following manure was applied per acre: Stable manure, 8,920 lb.; superphosphate of lime, 178 lb.; chloride of potash, 178 lb.; and at the end of May a dressing of 178 lb. of nitrate of soda was given.

Seed of an Upland variety was sown on the 3rd and 4th April, after having been soaked in water for 24 hours to hasten germination. The distance between the plants was two feet. The soil was loosened in May, June, and July. Picking was commenced on the 26th August and was finished on the 10th November. The plants attained an average height of 40 inches and an average width of 32 inches. The yield per acre amounted to 514 lb. of lint and 1,029 lb. of seed. The cost of working was about £8 16*s*. per acre, the value of the cotton and seed was about £15 4*s*. per acre, and the profit obtained was therefore about £6 8*s*. per acre. It is stated, however, that in the case of larger plantations it would not be possible to give so much attention to the cultivation, and, on this account, the income would be at least 20 per cent. less than that mentioned above. The success of this experiment is largely due to the fact that the district of Jerez, being near the sea, receives a great deal of humidity which is denied to the more inland districts.

The experiment on irrigated land was carried out on soil which, when dried, gave the following percentage results on analysis: Nitrogen, 0·0622; phosphoric acid, 0·0920; potash, 0·0875; lime, 4·48; organic matter, 0·10. The quantity of manure given per acre was as follows: Stable manure, 35,700 lb.; superphosphate of lime, 357 lb.; and chloride of potash, 134 lb.;

when the plants had developed, a dressing of 134 lb. of nitrate of soda was applied.

The varieties of cotton grown were Upland, Yannovitch, Georgia, Mitafifi, Sea Island, and Louisiana. The seed was sown on the 6th May, and the land was irrigated on the 2nd June, 25th June, and 16th July. The distance from plant to plant was two feet, and from ridge to ridge, four feet.

The results of the experiment are presented in the following table, which gives the quantity and value of the cotton and seed yielded by each variety, together with the total cost of cultivation and the profit or loss entailed.

Variety of Cotton.	Cotton produced *per acre.*		Seed produced *per acre.*		Cost of working *per acre.*	Profit *per acre.*
	Quantity. lb.	Value. £ *s.*	Quantity. lb.	Value. £ *s.*	£ *s.*	£ *s.*
Upland . . .	477	13 0	954	1 11	11 11	3 0
Yannovitch . .	433	11 0	867	1 8	11 11	0 17
Georgia . . .	207	5 5	682	1 2	11 11	(Loss, £5 4*s.*)
Mitafifi . . .	460	11 13	920	1 10	11 11	1 12
Sea Island . .	271	12 6	856	1 8	11 11	2 3
Louisiana . . .	393	10 14	786	1 5	11 11	0 8

A summary of the results obtained in different experiments at the official establishments shows an average expenditure of about £9 10*s.* per acre, an average return of about £14 11*s.* from the cotton and 14*s.* 6*d.* from the seed, and consequently an average profit of about £5 15*s.* 6*d.* per acre. From the details of the experiments it has been calculated that, on the average, the cotton costs 4¼*d.* per lb. to produce.

Numerous experiments have also been undertaken by private individuals. An area of 148 acres was planted with cotton in the Province of Sevilla, of which 111 acres were non-irrigated and the remainder was watered from time to time. The crop on the non-irrigated land was entirely lost owing to lack of rain. The 37 acres which were watered yielded a crop of 15,435 lb., or about 417 lb. per acre.

NEW ZEALAND HEMP.

THE fibre known as New Zealand hemp or New Zealand flax is obtained from the leaves of *Phormium tenax*, a member of the natural order *Liliaceæ*. It was first introduced to the notice of Europeans by Captain Cook, who states (*A Voyage to the Pacific Ocean*, 1785, vol. i., p. 149) that there is a plant "which deserves particular notice here, as the natives make their garments of it, and it produces a fine, silky flax, superior in appearance to anything we have, and probably at least as strong. It grows everywhere near the sea, and in some places a considerable way up the hills, in bunches or tufts, with sedge-like leaves, bearing on a long stalk yellowish flowers, which are succeeded by a long, roundish pod, filled with very thin, shining, black seeds."

The plant exists in several varieties. The long sword-shaped leaves grow in opposite rows and clasp one another at the base; each leaf is folded in two longitudinally, the outer surface being shiny and the inner surface dull. The leaves of one variety are from five to six feet long, whilst those of another variety are only about half this length.

The following are some of the more important varieties, with their native names:—

"Harakeke" or "Common Swamp" grows almost everywhere in New Zealand, but attains its largest size (14 to 15 feet) in rich alluvial soil on river banks; its leaves are coarse, and afford a large yield of coarse fibre.

"Paretaniwha" or "Yellow Hill" grows generally on clay hills, and is seldom more than five or six feet high; its fibre is soft, glossy, and strong.

"Tihore" grows in rich, dry, alluvial land, and rarely attains a height of more than six feet; its fibre resembles that of "Paretaniwha."

"Nguturua" has a fairly long, thin leaf which has a tendency to droop when fully grown; the fibre is very fine, strong, and silky.

"Huiiroa" has a wide leaf of medium length with a very black edge, and yields a fine, strong fibre.

"Katiraukawa" resembles "Huiiroa," but grows less vigorously and has a longer leaf.

"Putaiore" has a long, narrow leaf, grows rapidly, yields a fine, strong fibre, and is commonly used by the natives for making mats.

"Urumea" has a long, straight, very green leaf, and furnishes a thick, hard, very coarse and strong fibre; this variety is sometimes known as "Takirikau" from the fact that, in preparing the fibre, the natives score the leaf just as with other varieties, but, instead of scraping it, they "takiri," *i.e.* pull quickly one end from the centre, then the other, the fibre coming out from tip to butt.

The varieties grown on high and dry lands are smaller, but yield a finer fibre and are much more easily stripped than the plants grown on marshy land.

Phormium tenax is indigenous to New Zealand, and is also found in Norfolk Island and other parts of Australia. It has been distributed to the Azores, St. Helena, Algeria, the south of France, Natal, South India, and California. The plant has also been introduced into the south of Ireland, and flourishes on the west coast of Scotland. It is planted in the Scilly Isles in order to resist encroachments of the sea, and has been cultivated in the Orkney Islands.

In the south of New Zealand the plant is not found far from the sea nor at a great elevation; in the North Island it grows best near the coast, but is also found abundantly in the interior up to a height of 2,000 feet.

Cultivation.

In order to obtain *Phormium tenax* fibre of good quality the plant must be cultivated on suitable soil, although almost any soil is capable of supporting its growth. The plant thrives best on a rich, moist, well-drained soil, and is found in its greatest luxuriance in the vicinity of swamps and rivers upon moist, alluvial soil. It also grows well on a rich, dry, clay soil with a yellow clay sub-soil, especially if sheltered from the wind and at the same time provided with plenty of light and air. The plant does not give good results on stagnant marshes, but grows well after such swamps have been drained. Drainage is effected by

means of open trenches of a depth sufficient to keep the water about twelve inches below the surface. In the dry summer months these drains may be temporarily stopped, if desired, in order to irrigate the soil. Alluvial soil is ploughed in the winter or spring, and left to dry until the autumn, when it is again ploughed. Planting is then carried out, usually in March or April, when the autumn rains commence. Early planting is advantageous, as the plants put out roots during the winter, and are thus enabled to grow vigorously with the advent of spring.

Propagation can be effected by means of seed or by division of the roots. The former method is not satisfactory, since the early growth of the plant is very slow and the seedlings are apt to develop characters different from those of the parent plants. The usual plan is to plant out the roots at a distance of six feet from one another in rows six feet apart, this arrangement giving about 1,000 plants to the acre. It is not improbable, however, that it would be more advantageous to allow not more than four feet between the rows and three feet between consecutive plants, as in this case the plants would shelter one another and would produce finer fibre, whilst at the same time an economy of soil would be effected. Should the land become impoverished as a result of planting so closely, manuring must be resorted to. According to another method, ten or twelve rows of plants are set in close proximity, and then a road-space of ten or twelve feet is left in order to facilitate the gathering of the leaves.

One Phormium plant yields twenty to thirty roots suitable for transplanting. Some difference of opinion exists as to the number of roots which should be planted together. If the plants are being set wide apart, two or three roots may be placed in one spot, but if close planting is adopted, one root is sufficient. Care must be taken to avoid planting roots which have borne a seed-stem or those from the centre of an old plant, since these are not so productive and are liable to flower, the nourishment being thereby diverted from the leaves. Flower-stalks must be removed as early as possible, and the wound rubbed with a little dry earth to prevent "bleeding."

The *Phormium tenax* plants usually grow together in tufts or bunches containing, on the average, ten shoots, each bearing five leaves; thus each group of plants has about fifty leaves.

The leaves vary in length from three to ten feet, and are not ready for cutting until the plants are from five to eight years old, according to the conditions under which they are grown. In New Zealand the leaves are usually cut in December or January. If two or three of the centre leaves of each plant are left untouched, a crop of three or four leaves can be obtained each year.

The suitability of the leaves for cutting is judged by their texture and firmness, or by a splitting at the apex, or the re-curving of the blade from the midrib. As already stated, only the outer leaves should be cut; in order not to injure the leaves enclosing the central shoot, the knife is inserted between the leaves, and the outer leaves are cut downwards and outwards.

Preparation of the Fibre.

The method of extraction practised by the natives, who use only the upper part of the leaf and only one side of it, consists in scraping away the softer tissues with the edge of a mussel-shell and subsequently soaking the fibre in water and drying it. Early in the last century considerable quantities of fibre were prepared in this way, 60 tons, of total value £2,600, being exported in 1828, 841 tons in 1830, and no less than 1,062 tons in 1831. The fibre thus produced by the natives is of much finer quality than that obtained by the use of machinery.

There are several machines which are used for extracting New Zealand hemp, but they are all constructed on the same principle. The leaf is introduced between horizontal, fluted, revolving feed-rollers, by which it is crushed and held securely while being scraped. As it passes out, the epidermis and parenchymatous tissue are stripped off by means of a beating-drum, revolving more rapidly than the feed-rollers and carrying flanges on its periphery which press the leaf against a bar and thus exert a scraping action. An arrangement is provided for adjusting the distance between this bar and the drum so that neither can the leaf pass through unstripped nor the fibres be cut. Vulcanised indiarubber cushions or steel springs are placed over the journals of the upper feed-roller so as to accommodate the varying thickness of the leaves. The quality of the fibre produced depends largely on the form of the scrapers or beaters

and the speed of revolution of the drum, but more on the ease and accuracy with which the machine can be adjusted.

After leaving the machine the fibre is cleaned by means of revolving brushes, which brush off all the pulpy matter left on it from the stripping-drums. The product is, in some cases, passed through a "finishing" machine, by which the strands of fibre are divided into finer filaments. The fibre is soaked in water for a time, then spread out in the sun to be bleached, and afterwards hung on lines to dry. The dry fibre is packed in bales and pressed for shipment. A full description of the principal machines and details of the methods employed are given in Spon's *Encyclopædia of the Industrial Arts, Manufactures, and Commercial Products*, vol. i., pp. 988–992.

In connection with this question of machinery the following note, which appeared in a United States Consular Report in 1890, is of considerable interest:—

"To imperfect machinery and carelessness in the selection of green plants may be ascribed the apparent coarseness and the inferiority so often complained of in the flax exported from certain portions of New Zealand. But with improved flax-dressing machinery and proper care exercised in the selection of the raw material, a very superior article can be produced. The fibre of *Phormium tenax* is susceptible of a much higher degree of preparation than has been bestowed upon it up to the present. This, however, is not altogether the fault of those who are engaged in its manufacture; it is for want of the necessary machinery. The hand-dressed article prepared by the natives is as fine as silk as compared with the modern machine-dressed flax of to-day. This only demonstrates the fact that the fibre may be reduced to a much finer quality, and all that is necessary to do this is an improved machine."

Yield.

The yield of fibre from the green leaf of *Phormium tenax* is usually given as about 10 to 14 per cent.

It is stated that there is a great difference in the yield per acre afforded by ordinary swamp flax, that is, Phormium grown in the ordinary way, and the cultivated plant. The average yield of green leaves from an acre of uncultivated flax is 10 to 15

tons, rich lands sometimes furnishing as much as 25 tons, whilst an acre of cultivated flax grown on good soil yields 45 to 55 tons. Moreover, the cultivated plant gives a much higher percentage of fibre; the yield is one ton of fibre from 7 tons of leaves of the cultivated plant, and one ton from 8 or 9 tons of uncultivated. The fibre from the cultivated plant is also of better quality than that from the uncultivated.

The cost of production varies to some extent according to the locality and the conditions, but it has been estimated that at Wairoa a ton of fibre ready for shipment costs about £14 to produce. In view of the prices at which the product is sold, it is evident that the industry should be very remunerative.

The following are the prices at which New Zealand hemp has been quoted in the London market in July of the years 1903–06:—

July 1903, £31–32 per ton.
„ 1904, £29–31 „ „
„ 1905, £24–26 „ „
„ 1906, £33–35 „ „

At the present time very high prices are ruling, the fibre being quoted in February 1907 at £37 10*s*. to £40 10*s*. per ton.

Characters, Properties, and Uses of the Fibre.

New Zealand hemp is a nearly white, lustrous, soft, flexible fibre. A comparison of its strength with that of other kinds of hemp was made some years ago by a firm of rope manufacturers, with the following results, which represent in each case the average strength of 50 yarns, all spun 25-thread by the same machinery:—

Manila.	Italian.	New Zealand.	Sisal.	European.
245	221	143	128	122

The bundles of ultimate fibres form filaments of unequal thickness, but these filaments can be separated into finer strands by friction. It is for this reason that the hand-prepared fibre is so much finer than that prepared by machinery. The former is said to be as soft as fine flax, and suitable for the manufacture

of fine textiles. The machine-prepared fibre, however, being coarser, is chiefly used for the manufacture of rope, twine, and floor-matting.

There appears to be no demand in the United Kingdom for the finer qualities of the fibre, only the third grade ("good fair") being imported. A fair amount of the higher qualities, however, is exported to Japan.

Microscopic examination shows that the ultimate fibres vary from 3 to 15 millimetres (or 0·12 to 0·75 inch) in length, and from 0·01 to 0·02 millimetre (or 0·0004 to 0·0008 inch) in diameter, and are regular and uniformly thickened. The surface is smooth and free from markings or striations. The fibre substance is strongly lignified.

Production and Export.

When the colonists first arrived in New Zealand the valuable qualities of the Phormium fibre were well known, as it was in constant use by the natives, and constituted the first article of barter in the trade carried on by the Maoris with Europeans. A very considerable trade in the fibre existed as early as 1828, when the Islands were only visited by whalers and Sydney traders, £50,000 worth being sold in Sydney between 1828 and 1832. A factory for the manufacture of articles from New Zealand hemp was established at Grimsby in Lincolnshire in 1832, but failed for some unexplained cause, notwithstanding that the results at the time were regarded as satisfactory. From 1853 to 1860 the average annual value of the fibre exported was £2,500, reaching as high as £5,000 in 1855; but up to that time the only fibre exported was that prepared by native labour, no machinery of any kind being used. In 1860, therefore, when the native disturbances affected the Waikato, and other interior districts of the North Island, the production was confined to the native tribes north of Auckland, so that in 1861 the export fell to two tons, of value £43. Attempts were then made to devise machinery by means of which the fibre could be profitably extracted by European labour. About this time the increasing demand for white rope and the limited quantity of Manila hemp available led to a rise in the value of New Zealand hemp from £21 to £56 per ton, and even to £76 in America during the

Civil War. These high prices stimulated the endeavour to introduce Phormium to compete with Manila, and several machines were invented for rapidly producing the fibre from the green leaf. With these machines the export trade again increased, so that from 1866 to 1871 the yearly average was about £56,000. The total quantity exported between 1864 and 1876 amounted to 26,434 tons, valued at £592,218.

Quantity exported in 1878, 622 tons, valued at £10,666.
" " " 1881, 1,308 " " " £26,285.
" " " 1884, 1,624 " " " £24,500.

In order to encourage the industry, the New Zealand Department of Agriculture has repeatedly offered bonuses for a machine which should be an improvement on the machines or processes in use, and which should be found to reduce materially the cost of production, improve the product, or increase the yield of dressed fibre. Another bonus was offered for a process for utilising the waste products of the hemp. A considerable number of inquiries were made with regard to these bonuses, but apparently nothing resulted beyond some slight improvements in existing machines, and the adaptation of machines used in the preparation of other fibres.

Owing to the complaints of rope and cordage manufacturers with regard to the lack of uniformity in New Zealand hemp, parcels bought under the same classification and shipped from the same port varying in colour and preparation, the Government passed an Act in 1901 providing for the establishment of a grading station for the compulsory grading of all hemp exported. As a result of this the quality of the fibre rapidly improved, and the confidence of buyers has been secured. The system employed in grading hemp for shipment consists in giving points according to the following scale:—

Stripping and washing, 30; colour, 25; scutching, 20; strength, 20; finish, 5; total, 100.

The highest grade, "superior," must score 95 marks or over; "fine," 85–94; "good fair," 75–84; "fair," 60–74; "common," under 60. To each bale a tag is affixed stating the grade of the fibre and bearing the signature of the grader.

At the present time certain modifications in the scale of grading are under consideration, according to which 20 points

each would be allotted to stripping, washing, colour, scutching, and strength, whilst the points given for finish would be dropped. As the export of tow is now assuming somewhat large proportions, the desirability of grading this product also is being considered.

The following table gives the quantity and value of the exports for every fifth year from 1856 to 1896, and for each year from 1897 to 1905:—

Year.	Quantity. Tons.	Value. £	Year.	Quantity. Tons.	Value. £
1856	22	552	1897	2,769	30,674
1861	2	43	1898	4,850	74,556
1866	45	996	1899	10,371	184,411
1871	4,248	90,611	1900	15,906	332,182
1876	897	18,285	1901	10,171	195,728
1881	1,308	26,285	1902	20,852	534,031
1886	1,112	15,922	1903	22,652	595,684
1891	15,809	281,514	1904	26,936	710,281
1896	2,968	32,985	1905	27,877	696,467

In 1904 the total quantity of New Zealand hemp (including tow) exported amounted to 28,137 tons, of value £714,147, and was distributed as follows:—

	Tons.	£
To the United Kingdom . . .	19,918	506,832
„ „ United States of America .	3,949	106,872
„ South Australia . . .	336	9,081
„ Victoria	1,499	32,865
„ New South Wales . . .	2,014	47,145
„ other countries . . .	421	11,352

Cultivation and Production of New Zealand Hemp in St. Helena.

Phormium tenax has been planted somewhat largely in St. Helena, and was cultivated successfully during the years 1876–1880. The largest amount of the fibre exported in any one year was 615 bales in 1879, and the greatest value of the export (£1,890) was reached in 1880. A factory was established at Jamestown for extracting the fibre, but as this was several miles distant from the plantations the cost of transport absorbed all the profit.

The question of reviving this industry in St. Helena came to the front in 1904, and in 1905 an attempt was made to extract the fibre on a commercial scale. This effort did not meet with much success, owing partly to the difficulty of raising the necessary capital, and partly to the fact that the machinery purchased was not altogether satisfactory.

A further endeavour is being made at the present time to re-establish the industry with Government assistance and under the guidance of an expert from New Zealand. Samples of the fibre which have been forwarded from St. Helena to the Imperial Institute have been found to be of very good, marketable quality.

Cultivation and Production of New Zealand Hemp in the Azores.

The cultivation of *Phormium tenax* is now being carried on in the Azores. The plant is said to grow well in all parts of the island of St. Michael, and the leaves vary in length from 6 to 8 feet. A factory has been established there, and produces some 50 tons of fibre per annum, the whole of which is exported. On an estate at Lameiro, Phormium plantations cover an area of 250 acres. The plants are regularly arranged at a distance of 6 feet from one another in each direction. The machine employed is capable of treating about 10,000 lb. of green leaves per day of 8 hours, with a yield of 600 lb. of dry fibre.

THE RUBBER EXHIBITION IN CEYLON.

THE cultivation of the Para rubber tree (*Hevea brasiliensis*) has been widely taken up by planters in Ceylon and the Malay Peninsula during the last ten years, and the results have been so successful that the enterprise has already become one of the most important industries in these countries. In view of the widespread interest which rubber cultivation has attracted, it was thought in Ceylon that it would serve a very useful purpose if a Rubber Exhibition were organised which would illustrate all phases of the industry and afford an opportunity for discussing the many problems which arise in the tapping of the trees and

the preparation of the rubber. An Exhibition was consequently arranged under the auspices of the Ceylon Government, and was held at Peradeniya from the 13th to the 27th September last. A large number of prizes were offered for the best samples of Para, Ceara, Castilloa, and Ficus rubber; for tapping instruments; and for machines used in straining and coagulating the latex, and preparing the rubber in suitable form for export.

The Exhibition proved to be a complete success, and was visited by large numbers of officials, planters, and others interested in rubber cultivation. The official account of the proceedings has recently been issued—*Rubber in the East* (the Government Printer, Colombo), edited by J. C. Willis, M. Kelway Bamber, and E. B. Denham—and a short abstract may be here given.

Special buildings, constructed throughout by natives in Kandian design, were erected for the Exhibition, and proved to be a very interesting feature to the visitors. In addition to the exhibits of raw and manufactured rubber, and the various instruments and machines connected with the rubber industry, a collection of the other chief products of the island, including various catch-crops suitable for growth on rubber plantations during the early years, was shown by the Ceylon Agricultural Society. There was also an Arts and Crafts section, where native artists and craftsmen could be seen at work.

A number of lectures on various points of interest to rubber planters were delivered during the Exhibition by members of the Botanical Departments in Ceylon, the Federated Malay States, and India, and also by the judges, Messrs. S. Brett, C. Devitt, and C. K. Smithett, from England. These lectures, some of which will be referred to later, were followed by useful discussions, in the course of which many expressions of opinion were obtained from the assembled planters. In addition, practical demonstrations were given of the different methods employed in tapping the trees, coagulating the latex, and preparing the rubber.

It will be convenient before proceeding to deal with the exhibits to summarise briefly the present position of the rubber industry in the Far East. The latest estimate of the area devoted in Ceylon to rubber, either alone or in conjunction with

other crops, is 104,000 acres in the hands of European planters, and probably another 10,000 acres in native hands. The exports of rubber from the island during 1906 amounted to about 186 tons. In the Federated Malay States it is estimated that 55,000 acres are already planted with rubber, whilst in addition 100,000 acres have been alienated for the purpose.

The question as to the best method of preparing the rubber for export has attracted much attention, and the exhibition of different forms of rubber enabled direct comparisons to be made between the rival processes. Until recently the great bulk of the rubber has been prepared in "biscuits," but, owing to the increasing output and the large amount of labour necessary for this process, other methods involving the use of machinery have been introduced. In these the freshly-coagulated rubber is treated in a form of washing machine, similar to those used by rubber manufacturers, and is thereby obtained in thin "sheets" or in "crêpe," both of which forms are very readily dried. Quite recently, however, a further step has been taken by the preparation of the "block" rubber described below.

The samples of rubber shown at the Exhibition were of very fine quality, and in almost all cases the premier place was taken by Ceylon planters. The prize for the best commercial sample of Para rubber in the show, open to all exhibitors, was, however, won by the specimens of block rubber from the Lanadron Estate in Johore. It should be noted that the exhibits sent in by Malay planters were large samples weighing 28 lb. each, whereas the Ceylon exhibitors restricted themselves to the 5 lb. which was stated in the catalogue to be the minimum quantity.

Several points of interest in connection with the samples may be noted. The gold medal for the best sample of Para rubber biscuits produced in Ceylon or abroad was won by the Duckwari Estate in Ceylon, which lies at an elevation of 2,600 to 3,000 feet. The sample was obtained from ten-year-old trees, and the latex was coagulated by means of cream of tartar dissolved in rubber whey. Several other estates lying at similar elevations also obtained prizes in other classes. These results demonstrate the possibility of producing good rubber at such altitudes under favourable conditions, although the slower growth of the trees in these situations has to be taken into account.

Promising samples of rubber were also shown which had been grown under irrigation at the Government Experimental Station at Maha Iluppallama, and the results appear to show that large areas in Ceylon, at present untouched, will be suitable for rubber cultivation if irrigation can be practised.

The block rubber which took the prize for the best commercial sample was prepared by making the freshly-coagulated rubber into "crêpe," drying this in a vacuum drier, whereby it becomes slightly sticky, and then compressing it into suitable-sized blocks by means of a press. It is claimed for this form of rubber that it is easier to prepare than the biscuits, costs less in freight, and suffers less by oxidation in transit. This block rubber has been very well received in this country by manufacturers and brokers, and has realised *2d.* to *3d.* per lb. more in the London market than the biscuits. It is doubtful, however, whether this increase in price would be maintained if large supplies of block rubber were placed on the market, but there seemed to be a consensus of opinion that, owing to the convenience of manufacture and the reduction in freight, the preparation of rubber in this form will be widely adopted in the near future.

Experience has shown that the Para rubber in biscuits from Ceylon is less strong and resilient than fine hard Para from South America, and many explanations have been put forward to account for this fact. It has been suggested that the Ceylon biscuits are dried too thoroughly, as they usually contain only 0·5 per cent. of moisture, compared with from 10 to 15 per cent. in the South American Para. In the discussion which followed one of the lectures, Dr. Willis suggested that it would be of interest to compress a quantity of moist Ceylon biscuits into block form, which could be sold for comparison with the dry biscuits. This has since been done, and the block rubber, containing about 9 per cent. of water, was sold in London for 5*s.* 6*d.* per lb., against 5*s.* 7*d.* to 5*s.* 9*d.* per lb. for the ordinary dry biscuits, thereby obtaining a much better price. No information is yet available as to whether the strength and resiliency of the rubber were improved by this treatment.

Some excellent samples of Ceara rubber were also shown, and the best specimens were valued by the judges at ½*d.* per lb. more

than the finest Para rubber at the Exhibition. A sample of Ceara sheet from Kondesalle, Kandy, was considered to be the best sample of rubber at the Exhibition. This rubber was obtained from 300 trees, eight to twenty years old, growing at an elevation of 1,500 feet. The sample of Ceara biscuits which was awarded the gold medal in its class was prepared from thirty-year-old trees growing at an altitude of over 3,000 feet on the Rangbodde Estate, Ramboda.

Since the Exhibition Mr. Bamber has analysed all the specimens of rubber which received awards, and the figures he has obtained are highly instructive. The following table gives the percentage composition of the samples which took the gold medals in the various classes specified:—

	Moisture.	Resin.	Proteids.	Ash.	Caoutchouc.
Para biscuits.					
Duckwari . .	0·68	2·32	3·00	0·36	93·64
Arapolakanda .	0·28	1·84	2·12	0·20	95·56
Para sheet.					
Syston . .	0·30	2·74	2·25	0·20	94·51
Para crêpe.					
Culloden . .	0·36	2·04	2·25	0·22	95·13
Para block.					
Lanadron . .	0·36	2·44	3·31	0·20	93·69
Ceara biscuits.					
Rangbodde .	0·70	3·80	2·12	0·80	92·58
Ceara sheet.					
Kondesalle . .	1·58	5·74	5·06	1·48	86·14
Rambong (Ficus elastica) block.					
Golden Hope .	1·32	5·48	1·06	0·52	91·62

It will be noticed that the five samples of Para rubber included in the above table show considerable variation in composition, the resin ranging from 1·84 to 2·74 per cent., the proteid from 2·12 to 3·31 per cent., and the caoutchouc from 93·64 to 95·56 per cent. The Duckwari biscuits, which were judged to be the best in the Exhibition, and the Lanadron block rubber, which took the prize for the best commercial sample of rubber, are represented as containing a lower percentage of caoutchouc than the other three samples, on

account of the larger amounts of resin and proteids present. The Ceara sheets from Kondesalle, which were valued at a slightly higher figure than the best Para, are seen to contain only 86·14 per cent. of caoutchouc and over 5 per cent. of both resin and proteids. These analyses indicate the difficulty that is experienced in correlating the results of the chemical examination of rubber as at present conducted with the physical characters as judged by buyers.

Professor Dunstan, in his address to the Section of Chemistry and Agricultural Science at the York meeting of the British Association (this *Bulletin*, 1906, **4**. 310), has drawn attention to this difficulty, and has expressed the need for more refined methods of chemical analysis. The essential point does not, however, seem to have been understood by several of those who took part in the discussions in Ceylon. At present the caoutchouc is usually determined "by difference" from the results of the direct determination of the other constituents. All the errors of the analysis are therefore concentrated in the stated percentage of "caoutchouc," whilst in the absence of an accurate direct determination of the caoutchouc the homogeneity of this constituent in different samples of crude rubber and in rubbers of different origin has to be assumed. The physical characters of rubber are still more roughly determined by the manual tests of brokers, and precise methods of determining strength and resiliency are much needed.

Until more accurate methods are in use for both these purposes the valuation of rubber must be mainly empirical.

Passing to the instruments used in tapping the trees, it may be noted that the old method of making V-shaped incisions has been abandoned in favour of spiral or "herring-bone" cuts. After making the initial incision the lower edge of the cut is pared or pricked at intervals of from two to ten days, so as to reopen the wound and obtain a fresh supply of latex. The Para rubber tree when treated in this way shows a "wound response," that is, the second tapping frequently gives more latex than the first, and the flow often continues to increase for some time. It is essential that the bark should be pared away slowly, as the renewed bark is not ready to be tapped for several years, and consequently the successive shavings should be as thin as possible.

This method of tapping necessitates the use of special knives for performing the different operations, and a number of these instruments were exhibited. Gold medals were awarded for the Bowman-Northway and the Miller knives, whilst the Wynn-Trimmins, Cameron, and Tisdall knives also received awards in the above order. There is little doubt that further improvements will be effected in tapping tools in the near future, as the question is receiving considerable attention from numerous planters.

Ceara and Castilloa trees cannot be successfully tapped in the same manner as Para, and there is room for special forms of knife suited to their peculiarities. Macadam's knife was awarded gold and silver medals respectively in the classes for instruments suitable for tapping Castilloa and Ceara trees.

In the machinery section the chief awards for washing machines and other apparatus suitable for treating latex or rubber went to Messrs. Brown and Davidson of Ceylon, and the Federated Engineering Company, Kuala Lumpur, Federated Malay States. There were no exhibits in these sections by British makers.

The lectures delivered during the Exhibition were of great practical interest to planters engaged in rubber cultivation, and some of them may be briefly noticed.

A visit was paid to the Gardens at Henaratgoda to inspect the first Para rubber trees received in Ceylon thirty years ago. Experimental tappings by different methods have been in progress here for some time, and Mr. Herbert Wright gave a summary of the results so far obtained. Opinions are divided as to the best method of tapping, the full-spiral, half-spiral, and "herring-bone" systems each finding advocates. The full-spiral method is the most severe, and is generally considered to be likely to damage the tree; it gives the largest yield of rubber in a given time, whereas the half-spiral system furnishes the largest yield per unit of bark removed. The ideal system of tapping is to adjust the rate of removal of the bark so that the original bark is not exhausted until the renewed bark is ready for tapping, *i.e.* until it is from three to five years old.

Experiments are in progress at Henaratgoda to determine (1) the relative value of different methods of tapping, the criteria being the yield of rubber per tree and per unit of excised bark; (2) the yields from trees tapped at certain

intervals, varying from once per day to once per month; (3) the relation between the yield of rubber and climatic conditions; and (4) the yield of rubber obtainable from different parts of the stem. With regard to the latter, it is of interest to notice that the Para trees at Henaratgoda occasionally yield latex which is not coagulable by the ordinary methods, and it has been found that this occurs much more frequently with the latex from the higher portions of the stem than with that from the base. This point is of importance in connection with the proposals to tap the higher portions of the stem.

Mr. Wright delivered another lecture on "The Cultivation of Rubber Trees," in which he attempted to forecast the future of rubber cultivation. He also gave a demonstration of the use of mechanical appliances for straining and coagulating the latex, and preparing the rubber in various forms.

Important communications were made by Mr. E. E. Green, the Government Entomologist in Ceylon, and Mr. T. Petch, the Government Mycologist, with regard to the insect pests and fungoid diseases likely to attack rubber trees.

Mr. Green is of opinion that healthy rubber trees are not liable to attack by bark-eating or boring insects on account of the protection afforded by the latex, but that if the laticiferous ducts become dry from any cause the trees will probably suffer from these pests. Young trees from two to three years old suffer most from insect attacks, and it is thought that in most cases this is the outcome of injury, direct or indirect, received at the time of transplanting. Attention was again drawn to the dangers incurred by the exclusive cultivation of a single species of plant over large areas, and Mr. Green emphasised the necessity for breaking up rubber plantations into separate areas by means of protective belts of other trees. To planters who are not prepared to sacrifice the land necessary for this purpose, he suggested planting belts of Rambong or Castilloa rubber trees amongst the Para. He also urged the necessity of every planter keeping a stock of insecticides and spraying apparatus, so that any attack of insect pests could be promptly dealt with.

With regard to the prevention of fungoid diseases, Mr. Petch recommended that greater care should be taken in the raising of seedlings. The position of the nursery should be changed from

time to time, or if that is not possible the land should be treated with lime before the next planting, in order to kill the fungus spores which will have accumulated in the soil. Immature seed should on no account be used for planting purposes, as the trees obtained from such seed are less hardy and less resistant to disease than those from fully mature seeds. The only fungoid disease seriously affecting rubber trees at present is the root disease caused by *Fomes semitostus*. This fungus always develops first on jungle stumps, especially those of the Jak tree, and spreads from these to the rubber trees through the soil. It is, therefore, of the highest importance that jungle stumps should be removed from rubber plantations. Another point to remember is that the closer the trees are planted the greater chance there is for root disease to spread. In the discussion which followed this paper the question of the close planting of rubber trees was raised, and the matter may be briefly referred to. The object of the rubber planter is to produce trees with tall straight trunks suitable for tapping, and the best method of accomplishing this is to plant close and thin out afterwards. Consequently many estates have been planted with trees 12 by 12 feet apart (*i.e.* 300 trees to the acre), or even less, but in these cases experience has shown that the planter as a rule is not willing to thin out his trees afterwards and reduce the number to one-half. It is not easy to kill off the trees by excessive tapping, and the stumps left after they have been cut out will tend to spread root diseases. Opinion is now inclining towards rather wider planting than has been adopted hitherto, and 15 by 15 feet, or better, 15 by 20 feet, is the distance recommended by the Botanical Department in Ceylon. The latter distance, 15 by 20 feet, gives 150 trees to the acre.

Mr. J. B. Carruthers, the Director of Agriculture in the Federated Malay States, gave an account of "Rubber Cultivation in the Malay Peninsula," where the industry has made remarkable progress during recent years. The climatic conditions in the Federated Malay States are exceedingly favourable to the growth of the Para rubber tree, as the necessary growing conditions, constant rainfall and sunshine, obtain all the year round. The total area of the country is 26,300 square miles, about 17 million acres, and it is estimated that the Para tree could be grown profitably over at least one-third of the land. The one difficulty

in extending rubber cultivation in the Federated Malay States is the scarcity of labour.

A similar paper was read by Mr. E. G. Windle, on "Rubber in South India," in which he gave an account of the experiments which have been made there with Para, Ceara, and Castilloa rubber trees. Rubber planting has not made such rapid progress in Southern India as in Ceylon or the Federated Malay States, but the industry appears to have now got beyond the experimental stage, and promises to develop considerably in the near future. The climatic conditions are very different from those of Ceylon, being much hotter at similar elevations, but except in certain districts there are at least three months of dry weather, or with a rainfall of less than one inch per month. Where the rainfall is sufficient the Para rubber tree can therefore be grown at much higher elevations than in Ceylon, and Mr. Windle quoted a case of healthy, though slow-growing, Para trees at an elevation of over 5,000 feet in the Nilgiris. It is estimated that there are at present about 13,000 acres under rubber, chiefly Para, in Southern India; of this total, 4,000 acres are coffee interplanted with rubber, and at least 8,000 acres consist of one- and two-year-old trees. Para rubber obtained from five-, six-, and seven-year-old trees in the oldest plantation in Southern India, on the Shevaroy Hills, has sold in London at 6*s.* per lb., whilst the same price has been obtained for Ceara biscuits from South Wynaad.

Papers were also contributed by the judges, who gave the planters advice regarding the shipment of rubber and the requirements of the London market; by Mr. M. Kelway Bamber, on a process for adding sulphur and other substances to the latex before coagulation with a view to vulcanisation; whilst Dr. J. C. Willis summarised the lessons to be learnt from the Exhibition. In addition, communications were made on a number of products suitable for use as catch-crops on rubber plantations, *e.g.* cotton, tobacco, lemon grass, and citronella, on camphor cultivation and preparation, and on the use and objects of Agricultural Societies.

The Exhibition appears to have fully realised the expectations of its promoters, and will no doubt have a very important influence on the progress of rubber cultivation in the Far East. The official account of the proceedings deserves careful study by all interested in rubber production.

RECENT DEVELOPMENTS IN PORTUGUESE EAST AFRICA.

THE two provinces of Lorenzo Marques and Mozambique together constitute Portuguese East Africa, which is contiguous on its southern, western, and north-western boundaries with the British territories of Tongaland, the Transvaal, British Central Africa, and Rhodesia, which together constitute a hinterland with the development of which the prosperity of this Portuguese possession, and especially of its ports, is naturally bound up. Similarly, the development of Portuguese East Africa is of some interest to those engaged in similar work in the neighbouring British possessions, and consequently it has been considered desirable to give an account in this *Bulletin* of the work recently done by the Mozambique Company, to which the commercial development of extensive territories (the provinces of Manica and Sofala) in Mozambique has been entrusted by the Portuguese Government, in exploring and utilising the natural resources of the country, and in encouraging agriculture.

The information given in the following account is taken mainly from a report on the districts of Goronzoga, Neves Ferreira, and Chimoio, by M. G. Vasse, who has been deputed by the French Government to spend three years in Mozambique studying the natural resources of the country.

MINERAL RESOURCES.

The results of explorations conducted in the three districts mentioned indicate that geological formations likely to be rich in metalliferous deposits do not occur. The principal rocks are reddish granites, diorites, and conglomerates. Large quantities of a milky-white quartz have been observed, with which copper is occasionally associated in the Goronzoga district. Butuminous schists occur in the Mudah Valley, and for a long time the existence of these has been assumed to be an indication of the occurrence of coal in this region ; but M. Vasse points out that the only trustworthy foundation for such a view would be the discovery of fossils dating from the coal-formation period, and such evidence is not forthcoming as yet.

M. Vasse has, however, found in the rapids of the Inhamissane a small piece of anthracite coal of excellent quality, and draws attention to the existence of hot sulphur springs at S'machoco as possibly indicating the occurrence of coal, since similar springs occasionally occur elsewhere in association with coal deposits.

Deposits of limestone have been found in the Goronzoga district, and this material is likely to prove useful for building purposes. No trace of the existence of deposits of iron ore has been found, and the natives appear to have no knowledge of such, since the tradition of Goronzoga states that the population has always obtained its necessary weapons and implements by bartering salt for them with the inhabitants of the mountainous district of Manica. This salt is collected from the dried-up plains after the rainy season is over. The best salt, *i.e.* the richest in sodium chloride, is said to be found on the Nyakapanda plain behind the village of Chikari. Manica is essentially the mineral district of Mozambique, and recent explorations by M. Vasse in this province near the Rhodesian border indicate that a considerable number of minerals of commercial importance occur. The district explored is drained by the Révoué and its affluents. These streams descend from granite highlands and flow over a series of metamorphic rocks consisting of quartzites and schists, which are traversed by numerous veins of auriferous quartz. Samples of the latter have been found to yield as much as thirty ounces of gold per ton, and the average yield of the richer veins is stated to be from six to seven ounces per ton. The alluvial deposits of the district are all more or less auriferous. Ores of lead, silver, arsenic, antimony, and iron occur in association with the gold, and in one locality copper ore is being worked. Veins of talc (French chalk) and asbestos are also stated to occur. M. Couyat, who has examined the samples collected by M. Vasse in Manicaland, reports that certain specimens of quartz from the Bragancia and Richmond mines are coated with crystals of mimetite, vanadinite, and wulfenite, respectively the chloroarsenate, chlorovanadate, and molybdate of lead. The mineral products obtained in Mozambique, and exported *via* Beira, in 1903, were valued at £11,484, and in 1904 at £6,458.

FOREST RESOURCES.

If the three districts, Goronzoga, Neves Ferreira, and Chimoio, are not rich in minerals of economic value, they appear to be amply compensated by possessing abundant forest wealth, and, as far as Goronzoga is concerned, a tolerably good climate, a fertile soil, and abundance of streams, which can be applied to irrigation.

Appended to the report is a list of plants, mostly indigenous to the country or now thoroughly acclimatised, including valuable timber trees, and plants yielding fibres, rubber, tanning materials, gums, resins, and food products of various kinds Unfortunately, this list gives, in the majority of cases, only native names, which are of little use outside the country, so that it is difficult from this list alone to get a clear idea of the value of the forest products obtainable. Fortunately, this difficulty can be overcome to some extent by means of a preliminary list of dicotyledonous plants occurring in Mozambique, recently published by Mr. J. A. Alexander, Director of Agriculture at Beira (*Proceedings of the Botanical Society of Edinburgh*, 1906, p. 167).

Rubber.

Rubber-yielding trees are stated to be widely distributed, especially *Landolphia Kirkii*, whilst *L. Thollonii* is known to occur in the forest region between Inhanconde and Tambarara. *L. petersiana* (?), *L. watsoniana*, and *L. florida* have also been recorded. The first four of these yield marketable rubber, but from *Landolphia florida* only a resinous product of no commercial value is obtained (compare *Bulletin of the Imperial Institute*, 1903, **1**. 68; 1904, **2**. 95, 153, 221; 1905, **3**. 324; and 1906, **4**. 223). A number of plants yielding latices worth further investigation are mentioned, such as T'chinga or Nicuza and M'tsa, which are used by the natives for making bird-lime. It is stated that a few trees of a species of Ficus, which yields latex, are to be found in the neighbourhood of Beira.

The only rubber plant cultivated to any extent in Mozambique at present is the Ceara rubber tree (*Manihot Glaziovii*), plantations of which have been formed at Macuire, Bue Maria,

Tambarara, and Inhanconde, and, as has been observed in other countries where this tree has been planted, the results obtained are not, in M. Vasse's opinion, encouraging. He states that the tree produces very brittle branches when grown in a clay soil, and that under these conditions the plants suffer severely in a strong wind, whilst when they are planted in sandy soil the results are even worse, for then the trees are frequently uprooted by the wind. As an illustration of the damage caused in this way a case is quoted in which, in a plantation, two years old, only two trees out of 1,500 originally planted were left standing, the rest having been first broken by the wind and finally destroyed by the attacks of termites. It is considered that the natives may find it possible to grow Ceara trees, since they are content with a small return, but plantations of Ceara rubber trees are not likely to pay in the hands of Europeans. M. Vasse suggests that an expert botanist who has made a special study of rubber plants should be engaged to visit the country and investigate its natural rubber resources, and the possibility of introducing exotic species for cultivation. During 1904 rubber to the value of £7,642 was exported from Beira, and in 1905 this had increased to £9,109 [*Diplomatic and Consular Reports* (Cd. 2682–93), p. 6].

Timber.

The most important trees found in Mozambique from the point of view of export trade are ironwood, ebony (*Dalbergia Melanoxylon*), and mahogany, and some trade in the two latter is already done. The woods yielded by the trees bearing the native names Couzambira and Magrego are stated to be suitable for cabinet making, whilst Koniti furnishes an aromatic wood used by the natives for making neck ornaments. The branches of *Millettia caffra* are used by the Kaffirs for making walking-sticks and knobkerries. The export of timber from the territories of the Mozambique Company through Beira in 1904 was valued at £134.

Resins and Gums.

Nine species yielding products of this class are enumerated by M. Vasse, and it is stated that the hard yellow resins produced

by the M'Fitti, Tcifiti, and Mouringari trees are exported to France, where they are worth 60 centimes to 2 francs per kilo.

Dyes and Tanning Materials.

The indigenous natural dyes are, of course, of little value now, except possibly for local use by the natives, since the use of dyes of vegetable and animal origin has almost ceased in civilised countries, owing to the competition of artificial dye-stuffs. Several species of Indigofera occur in the country, and reference may be made to the barks obtained from the Tchissio, M'Sousso, and Kataosarro trees, which are stated to dye black. Several of the archil lichens also occur in Mozambique, and are exported in small quantities for the manufacture of archil, cudbear, and litmus. The most important tanning materials produced are the barks of the mangroves, which flourish along the coast and on the adjacent islands. The principal species are *Rhizophora mucronata*, *R. racemosa*, *Ceriops Candolleana*, and *Bruguiera gymnorrhiza*. Some account of the trade in mangrove barks from Mozambique has already been given in this *Bulletin* (1905, **3.** 352). An extensive coasting trade in the "boriti" poles yielded by these trees is also done both in Portuguese and British East Africa.

Oil Seeds.

Two interesting trees yielding products of this class are the Ben Oil tree (*Moringa pterygosperma*) and the Mafoureira tree (*Trichilia emetica*). Both these oils have been investigated at the Imperial Institute, and full information regarding the former is given in this *Bulletin* (1904, **2.** 117). The Mafoureira nut yields a large percentage of a solid fat suitable for soap making. It is largely used in France, and has also come into use recently in this country (*Bulletin of the Imperial Institute*, 1903, **1.** 26). Other plant products of interest in this connection found in Mozambique are the cashew nut (*Anacardium occidentale*) and the castor oil plant, which grows wild, and from the seeds of which oil is prepared by the natives. The ground nut (*Arachis hypogea*) is extensively cultivated by the natives, frequently in association with sorghum. *Sesamum indicum* has also become

naturalised in the country, and large quantities of the seed are exported. The plantations of the oil palm (*Elais guineensis*) started some years ago by the Company were unsuccessful, and have been abandoned.

There are a few plantations of cocoanut palms, but these, it is stated, are not in good situations, and, so far, have not done well. The oversea exports of "ground nuts and oil seeds" from the territories of the Mozambique Company through Beira were valued at £639 in 1903, and £6,985 in 1904.

Fibrous Plants.

Twenty-one indigenous fibrous plants are enumerated by M. Vasse, including the native cottons (*vern.* Tonendje) and a variety of silk cotton (*vern.* M'goudza). The plants known as Sandzadjona, Payna, Condjé, and Niacanama yield fibres used in making bow-strings, whilst from M'poupo and Bonazi are obtained fibrous products employed by the natives in making articles of personal decoration, such as belts and bracelets. Straw hats are made from the leaves of the M'goré or Micheon (dwarf palm), and those of the Dom palm (*vern.* Nyangadzi or Dikona).

The Mozambique Company is encouraging the cultivation of fibrous plants, and among those now being grown experimentally are *Sansevieria guineensis*, *Furcræa gigantea*, *Agave americana*, and *Bœhmeria nivea* (ramie). Special attention is, of course, being paid to cotton growing. An account of the attempts made recently to encourage cotton cultivation in Portuguese colonies has been given already in this *Bulletin* (1905, **3.** 250), and it is only necessary in the present instance to add the further information now available. *Gossypium anomalum* and *G. herbaceum* are both found about the borders of the forests and abandoned lands. The natives pick the cotton from these wild plants, but it is short in staple and of little commercial value. European settlers have grown cotton to some extent, and M. Vasse and Mr. Alexander (*loc. cit.*) agree in stating that their efforts have not been wholly successful. The former attributes this mainly to lack of knowledge of the peculiarities of the cotton plant, whilst the latter states that the smaller growers have employed natives to pick wild cotton,

which was then mixed with the product obtained from imported Egyptian seed, thus depreciating its value.

The cotton plantations under the control of the Mozambique Company appear to have been fairly successful, and they are now endeavouring to induce the natives to take up cotton cultivation under supervision. In this connection M. Vasse urges on the Company the necessity of circumspection in allotting concessions of land for cotton growing to Europeans, since if these are unsuccessful they will have the effect of discouraging the natives. Three samples of cotton grown under the auspices of the Mozambique Company have been examined at the Imperial Institute. The first of these was of the Abassi type, and its staple varied from 0·9 to 1·5 inch in length. The fibres were somewhat uneven in diameter, and some of them were unripe. The second sample was of rather better staple (1·1 to 1·5 inch), but also contained some unripe fibres, and was rather uneven in colour. The third and best sample resembled Egyptian "Mitafifi" cotton, and consisted wholly of mature fibres, 1·1 to 1·5 inch in length, and of normal strength. These three cottons were sold by the Company at *6d.*, $7\frac{3}{4}$*d.*, and *9d.* per lb. respectively in the United Kingdom, good Egyptian cotton being worth from $9\frac{5}{16}$*d.* to $9\frac{7}{8}$*d.* per lb. on the day of sale. These results show that with care cotton of good quality can be grown in the country.

Miscellaneous Products.

Coffee is grown to some extent by the natives, but the type, apparently a degenerated Mocha introduced *via* Abyssinia, is a poor one, yielding a berry with a slight flavour of turpentine.

Tobacco is extensively grown by the natives for their own consumption, and considerable quantities are exported, but no special attempts to grow a good tobacco suitable for the market in this country have been made.

Pineapples are grown in large quantities, and M. Vasse makes the suggestion that the leaves might be utilised as a source of fibre. The principal food products grown are sorghum and cassava, and rice appears to be the only material of this type which can be grown at a profit by Europeans. A very large number of indigenous plant products are employed as drugs by the natives, but of these reference need only be made to the root

of the wild ginger plant, and to the fruit of the baobab tree, the acid pulp of which can be used for making refreshing drinks and is useful as a mild febrifuge (cf. *Bulletin of the Imperial Institute*, 1905, **4**. 252).

The sugar cane is extensively cultivated, and sugar forms one of the principal articles of export. It is produced principally in Goronzoga by a company of French origin, which carries on both the cultivation of the cane and the refining of sugar. The exports of sugar *via* Beira in 1903 were valued at £21,622, and in 1904 at £39,099.

ANIMAL PRODUCTS.

Comparatively little attention has been paid so far to the breeding of cattle, and though the natives raise cattle they have no system of selection, so that the herds show a tendency to degenerate. Reference is made to the severe losses of cattle occasioned by a disease, at first ascribed to the tsetse fly, but which M. Vasse believes is a form of biliary hæmaturia. He has obtained some success in treating this with salol and turpentine oil. The exports of hides *via* Beira were valued at £502 and £494 in 1903 and 1904 respectively.

Poultry farming is carried on to a considerable extent, but no development in this direction can take place at present owing to the prevalence of a poultry disease, which has caused much loss. This is being investigated at the Pasteur Institute with a view to the discovery of a remedy.

Bee keeping has made much progress in the country, but the native bees, in M. Vasse's opinion, are less productive than these insects are in Europe, and he suggests that a few hives of European bees should be imported with a view to improving the type. The export of beeswax from Mozambique, though still large, is decreasing, and this appears to be due in part to the barbarous method of collecting the wax employed by the natives. This consists in enlarging the opening of the nest and plunging into it a wisp of ignited straw, the smoke of which asphyxiates the insects. In this way the bees are being rapidly reduced in numbers. It is suggested that the natives should be taught to use the method employed in Madagascar, where the lighted straw is held just outside the opening of the nest, so that a thin

stream of smoke floats in. This is sufficient to drive the bees into the open air, when the wax and honey can be collected without destroying the nest, which can then be reoccupied by the insects. The destruction of the bees is not the only harm done by the natives in their search for wax and honey. When they find a nest in a large tree, which cannot be climbed easily, they usually cut the tree down, thus destroying timber of great value for the sake of honey or wax valued at a few pence. The honey produced in the Goronzoga Hills is white, solid, and of good flavour, whilst that obtained in the plains is yellow, semi-solid, and rather mawkish in flavour. The exports of beeswax from the Company's territories *via* Beira were valued at £8,337 and £5,714 in 1903 and 1904 respectively.

M. Vasse found in the Goronzoga Hills a silkworm, which has not been identified, but is probably identical with that known in Natal, and also a spider similar to the "mygale" of Madagascar, which is said to produce a marketable silk.

Other animal products which form important items in the export trade of Beira are ivory, horns of the rhinoceros and of other wild animals, hippopotamus teeth, and skins of birds. These together were valued at £1,387 and £895 in 1903 and 1904 respectively.

GAME AND BUSH FIRE REGULATIONS.

The report concludes with a number of observations on the laws at present in force with regard to hunting and to bush fires. Both these sets of regulations M. Vasse thinks might be modified with advantage, since they bear somewhat hardly on the natives, and cannot be enforced in their present form by the small police force available. With regard to bush fires, it is pointed out that the various peoples who have held the country from the time of the Phœnicians have never been able to stamp out the practice, though the conditions prevailing in early times, with regard to slavery, made this more possible than is now the case. It is admitted that indiscriminate firing of the bush is a serious matter for planters, but it is contended that their interests could be sufficiently safeguarded by the establishment of "fire zones." On the other hand, the regulations are vexatious (1) to settlers, since firing is the simplest and most expeditious method of

clearing land; (2) to cattle-breeders, as they require for their herds the tender grass, which readily springs up after the coarse growth of the previous season has been burnt down; (3) to hunters, and (4) to mineral prospectors. The regulations are still more vexatious to the natives, since the unburnt bush harbours lions, and other beasts of prey, to whom a considerable number of natives already fall victims every year, and their fear of these animals prevents them from gathering forest produce, and interferes with them in other ways, and so creates great discontent with the regulations. Apart from these economic and political considerations M. Vasse thinks that bush fires improve the hygienic condition of the country, since they prevent the formation of masses of decaying vegetation, and directly or indirectly destroy hosts of small animals and insects, which are injurious to crops and to cattle.

HARDWOODS OF WESTERN AUSTRALIA.

WESTERN AUSTRALIA is rich in timbers, and, although several are, for one reason or another, only in local demand, others have secured a recognised place amongst the commercial woods of the world. During the last ten years timber of the total value of about £4,500,000 has been exported, and of this total Jarrah accounted for some three and a quarter millions, Karri nearly one million, leaving only some £1,500 as the aggregate value of all the other woods exported. The Sandalwood finds its way chiefly to India and China, and need not be discussed further in these notes, which are restricted to the hardwoods, and of these, as the preceding figures sufficiently demonstrate, Jarrah and Karri are overwhelmingly the most important. Both are well known in the United Kingdom, and are exported also to many other parts of the world, including other States of the Commonwealth, New Zealand, India, Ceylon, Cape Colony, Natal, Egypt, and the Philippine Islands.

The Government of Western Australia has recently devoted considerable attention to the timber resources of the State, and has issued two important publications :—

(1) *Notes re Timbers of Western Australia suitable for Railways, Engineering Works, and Constructional Purposes generally.*

(2) *The Physical Characteristics of the Hardwoods of Western Australia*, by G. A. Julius.

The former embodies some of the conclusions of the State Royal Commission on Forestry, 1904, and contains a map showing the approximate situation of the principal timber forests. Western Australia is about seventeen times the area of England and Wales, and it is estimated that some 98,000,000 acres, or about one-seventh of the whole, is wooded, the extent of merchantable timber being approximately as under:—

	Acres.
Jarrah mainly (with Blackbutt and Red Gum interspersed)	8,000,000
Karri	1,200,000
Tuart	200,000
Wandoo (White Gum) and allied timbers .	7,000,000
York Gum, Yate, Sandalwood, and Jamwood	4,000,000
	20,400,000

The true forest region is almost entirely coastal, the most luxurious tree growth being confined to the mountains and hill ranges which to a large extent follow at a moderate distance the trend of the coast, and to the table-lands and foot-hills running from these towards the shore-line. The Jarrah belt stretches continuously for some 300 miles along the south-west portion of the State from a little east of Albany to about 40 miles north of Perth. In the south a broad band of Karri occupies the land between the edge of the Jarrah belt and the coast, whilst further north there is a narrow coastal belt of Tuart. Other important timbers, such as Wandoo, York Gum, Red Gum, etc., occur inland beyond the Jarrah belt, whilst the Blackbutt grows associated with the Jarrah, Karri, and Red Gum, and is not restricted to a definite area.

JARRAH (*Eucalyptus marginata*). Average Jarrah trees are from 90 to 100 feet in height, and 2½ to 3½ feet in diameter at the base; individual trees attain much greater dimensions. The wood when first cut weighs about 70 lb. per cubic foot, and 60 lb. when seasoned. It is dark red or reddish-brown in colour, very hard and dense, and generally of straight grain. The amount of

Jarrah suitable for mill purposes is estimated at 2,000,000 acres, or equivalent to about 32 years' supply at the present rate of cutting. In addition there are several million acres of Jarrah, of less value, but likely to be of local importance in the future for sleepers as the railway system is extended. Jarrah is most generally employed for railway construction, sleepers, marine and engineering works, building construction, and is especially suitable for underground use and where in contact with wind and water.

The exhibits of Jarrah in the Western Australia Court at the Imperial Institute afford evidence of the durability of this timber; amongst other specimens a section of a pile is shown which was in use in Bunbury Harbour for 30 years, and is still in perfect condition, as also is a portion of a fence post after having been for 50 years in the ground. Jarrah is not, however, resistant to the attacks of the teredo in tropical waters, although in temperate-zone waters it does not suffer any visible injury. The use of Jarrah for paving-blocks is well known, and for other purposes it gives good results and is very effective, as the overmantel, table-legs, chairs, carvings, etc., also exhibited in the Western Australia Court indicate.

KARRI (*Eucalyptus diversicolor*). This tree attains larger dimensions than Jarrah, average specimens being about 150 feet in height and 6 feet in diameter 3 or 4 feet from the ground. A section exhibited in the Western Australia Court is a little over 5 feet in width. In one district trees 300 feet in height are not uncommon. The wood is a little lighter than Jarrah, weighing 63 lb. per cubic foot when seasoned; it is red, heavy, tough, dense, and elastic, and very similar in appearance to Jarrah. The two may often be distinguished by the following simple test: "A splinter struck from Jarrah and placed in a flame generally burns to a firm black ash, one from Karri to a somewhat woolly-white ash; also, when the flame of the burning splinter is blown out, Karri tends to glow for some little time, Jarrah to go black out quickly." Karri is largely used for railway cars and wagon frames, for bridge timbers, flooring, street-paving blocks, and many other purposes. It is, however, not well suited for underground work or to damp situations, and Karri piles can only be employed in water not infested with boring pests. Like Jarrah, it is unusually

resistant to fire; it is, however, somewhat prone to dry rot.

TUART (*Eucalyptus gomphocephala*). The average height of Tuart is much the same as Karri, about 150 feet, with a girth of about 10 feet. The wood is cream-coloured, very hard and dense, with interlocked grain, and is exceedingly tough and strong. It is heavier than Jarrah, a cubic foot of seasoned wood weighing about 70 lb. Tuart is in demand for constructional purposes where special strength and hardness are required; thus it is used for the wheels of the large timber wherries in the forest, being preferred to iron. Naves, spokes, and felloes made of Tuart are exhibited in the Western Australia Court. As already noted, however, its geographical distribution is very limited, and the supplies are not extensive enough to provide for general use. Tuart is almost as resistant to fire as Jarrah and Karri.

BLACKBUTT (*Eucalyptus patens*) occurs scattered over the Jarrah and Karri areas. It attains to 120 feet in height and 6 feet in diameter, and yields a light-coloured, hard, dense wood, so tough as not to yield to ordinary splitting processes, and very durable underground. Owing to the habit of this tree it is impossible to form any estimate of the available supply. Blackbutt is chiefly in demand for local use, such as settlers' steadings, fences, wheels, shafts, and farm implements generally. It is suitable for sleepers, paving-blocks, and piles, and has been employed both in Western Australia and abroad for railway-wagon building. Amongst other useful characteristics it is notably non-inflammable.

WANDOO (*Eucalyptus redunca*). White Gum is another local name for this tree, which ranges from 60 to 80 feet in height and from 2 to 3 feet in diameter. The timber is brownish-red, and very hard, dense, strong, and durable. It is very heavy, weighing up to 70 lb. per cubic foot even when fully seasoned. Wandoo occurs over a wide extent of country, but is thinly distributed. For railway sleepers it is considered equal to Jarrah, and it is employed locally to a large extent for wheelwrights' work, boat keels, mining timbers, fencing, etc.

YORK GUM (*Eucalyptus loxophleba*) does not usually attain more than 80 feet in height and 3 feet in diameter; the wood is reddish, exceedingly hardy, dense, tough, and heavy, weighing

[*Continued on page* 69.

THE STRENGTHS OF AUSTRALIAN HARDWOODS.

Common name.	Botanical name.	State.	No. of tests made.	Load in pounds per sq. inch. Shearing.	End compression.	Cross bending.	Tension.	Total of loads in four directions.
Yate	*Eucalyptus cornuta*	Western Australia	425	3,200	11,600	21,500	24,200	60,500
Salmon Gum	*Eucalyptus salmonophloia*	" "	87	2,900	10,700	20,100	19,200	52,900
Iron Bark	*Eucalyptus paniculata, E. crebra*, etc.	New South Wales	83	2,200	10,150	18,940	19,530	50,820
Blackbutt	*Eucalyptus pilularis*	" " "	59	1,850	8,700	15,880	23,400	49,830
Karri	*Eucalyptus diversicolor*	Western Australia	925	1,800	10,200	17,300	18,750	48,050
Morrell	*Eucalyptus longicornis*	" "	69	1,980	11,100	16,900	18,000	47,980
Red Gum	*Eucalyptus colophylla*	" "	675	1,850	9,280	16,600	20,200	47,930
Tuart	*Eucalyptus gomphocephala*	" "	852	2,500	10,650	17,900	16,500	47,550
Blue Gum	*Eucalyptus globulus*	Vic. and Tas.	70	1,800	8,200	15,600	20,500	46,100
Turpentine	*Syncaypia laurifolia*	New South Wales	32	1,730	8,950	15,710	19,350	45,740
Wandoo	*Eucalyptus redunca*	Western Australia	771	2,680	10,850	16,100	16,100	45,730
Flooded Gum	*Eucalyptus saligna*	New South Wales	30	2,040	9,260	16,140	18,200	45,640
Grey Gum	*Eucalyptus propinqua*, etc.	" " "	30	1,770	8,810	15,340	19,260	45,180
Tallow Wood	*Eucalyptus microcorys*	" " "	32	1,670	8,470	17,240	15,970	43,350
Spotted Gum	*Eucalyptus maculata*	" " "	46	2,000	8,100	16,150	16,990	43,240
Grey or White Box	*Eucalyptus hemiphloia*	" " "	45	2,020	8,120	15,950	16,340	42,430
Jarrah	*Eucalyptus marginata*	Western Australia	689	2,010	9,050	15,000	15,500	41,560
Stringy Bark	*Eucalyptus obliqua*	Vic. and Tas.	126	1,900	7,700	14,300	16,600	40,500
Blackbutt	*Eucalyptus patens*	Western Australia	740	1,650	8,450	14,200	15,700	40,000
York Gum	*Eucalyptus loxophleba*	" "	330	1,900	9,900	14,500	13,000	39,300
Red Gum	*Eucalyptus rostrata*	Victoria	103	1,840	6,200	11,800	11,700	31,540

when seasoned about 68 lb. per cubic foot. For naves, felloes, and all kinds of wheelwrights' work it is excellent.

RED GUM (*Eucalyptus calophylla*). A widely-distributed tree of about 100 feet in height and average diameter of 3 feet. The wood is yellowish-red in colour, fairly dense, hard, tough, and strong; it is of lighter weight than the preceding timbers. Intersecting gum veins diminish its value for many purposes, and although not as yet very largely utilised, it is employed in short lengths for axe handles, spokes, naves, shafts, fruit cases, etc., and also makes very good round spars.

YATE (*Eucalyptus cornuta*). This timber is as yet practically unknown. The tree attains a height of about 100 feet, with a diameter from 2½ to 3 feet, and is common in the south-west of Western Australia. As a "sawn" timber it is probably the strongest in the world, being far ahead of the rest of the Australian hardwoods in every variety of test. In one tensile test a breaking load of 17½ tons per square inch was recorded, a value only 3½ tons below that usually specified for wrought iron of ordinary quality.

In the tests reported on by Mr. Julius special attention has been given to obtaining strictly comparable results. Thus, as an illustration of the unreliability of many previous experiments, the author instances the case of Jarrah, the tensile strength of which is given by three authorities as 2,940, 5,000, and 16,407 lb. per square inch respectively. Similar discrepancies occur in the recorded figures for other timbers. One factor of the greatest importance in causing this divergency has been shown by Professor J. B. Johnson, in his *Materials of Construction*, to be variations in the percentage of moisture present in the timber. "The absence of any determination of the moisture condition of the test material vitiates practically all tests of the strength of timber." In the West Australian experiments the moisture present in each specimen was determined immediately after the completion of the physical test. The examination was made as exhaustive as possible, specimens varying greatly in size and in degree of seasoning being separately tested, and on the more important timbers a very large number of tests were made, so as to obtain true average results.

The comparative strength of twenty-one of the chief Australian

hardwoods is summarised in the table on p. 68, adapted from Mr. Julius's results.

Other tests reported on are those to ascertain the holding power of the various timbers on "dog spikes," both with green and dry timbers, with spikes newly driven and with those that had been in place in railway sleepers for a number of years. All the results are set forth in the report in full, with numerous illustrations, curves, and tabulated schedule, and the whole affords a most useful addition to our knowledge of these important hardwoods, the more valuable because of the care taken to standardise the results.

For further information about these and other Australian woods, the articles on (1) Queensland timbers, (2) Tasmanian timbers, and (3) South Australian timbers, in the volume of *Technical Reports and Scientific Papers* published by the Imperial Institute in 1903, may be consulted, as well as the papers on the timbers exhibited in the New South Wales and Queensland Courts of the Imperial Institute, already published in this *Bulletin*, 1905, **3.** 119, and 1906, **4.** 1.

GRAPHITE: ITS OCCURRENCE AND USES.

THE first part of this article, dealing with the mining and preparation of graphite and its uses in the arts, was published in this *Bulletin*, 1906, **4.** 353.

DISTRIBUTION.

The United Kingdom.—The only deposits of importance in the British Isles were those of Borrowdale near Keswick in Cumberland, where it was formerly known as "black cawke" or "wad," and was originally used for marking sheep. As early as the middle of the sixteenth century it was manufactured into black-lead pencils, and for nearly three centuries practically all the material employed for the purpose came from this mine.

The mineral occurs in a compact, much-altered plagioclase augite rock described as a diabase, and in the adjoining, very similar, volcanic ash beds of the Borrowdale series. It occurs

near the junction of these rocks with an intrusive dyke which has the appearance of a diorite, but is too much altered for precise determination. The decomposed felspar, which forms the greater part of this rock, contains specks of graphite consisting of minute hexagonal plates. Strings of quartz also occur containing nests of graphite.

The mines are not now worked, and it is difficult to obtain exact information, but the mineral appears to have occurred in very irregular fashion in veins, beds, and pockets or "pipes." Large masses were met with at the intersection of the veins. It is not clear whether these masses are the same as the pockets or pipes, which are described as consisting of an "irregular waddy breccia" mingled with strings or bunches of quartz, and are stated to have been oval in section, sometimes measuring three yards in length by one yard in breadth. They descended a considerable depth, but began and ended suddenly. Infillings of graphite occurred in the joints in the neighbourhood.

From one pocket opened in 1803 over 30 casks, each containing about a hundredweight and a quarter of the best graphite, were obtained, besides a greater quantity of an inferior sort. In 1804 the stock then on hand was valued at £54,000, and the annual consumption at about £3,500.

In 1794 the best material was worth 63 shillings per lb.; in 1804 the price had fallen to 35 shillings, but in 1819 it had risen again to 45 shillings. In 1843 it was 30 shillings and in 1876 40 shillings, but long before the former date the deposits had given out, and though many attempts have been made to discover new pockets, they have never been successful.

Analyses of some of the Borrowdale graphite gave from 78·10 to 91·55 per cent. of carbon, 1·10 to 6·10 per cent. of volatile matter, and 7·35 to 15·80 of ash, consisting chiefly of silica, alumina, and iron. An analysis by Schräder gave as much as 3·15 per cent. of titanium oxide. The iron was probably mainly present in the form of pyrites. This graphite was not, therefore, of any exceptional purity, and it was the physical condition in which it occurred that gave it its value for pencils. The impure varieties were employed in the manufacture of crucibles.

Graphite has also been obtained from the "Bannerdale lode"

to the north of Blencathra in a spotted slate belonging to the Borrowdale volcanic series.

The mineral has been met with in Cornwall near Tuckingmill Camborne, and in a granite quarry on the Kergiliack Estate near Penryn.

There are numerous occurrences of graphite in Scotland, but none have been continuously worked. At Craigman, New Cumnock, in Ayrshire, is a seam from 3 to 6 feet thick composed partly of graphite, "compact, scaly, or columnar," and partly of glance coal. It appears that some of the coal has been metamorphosed to graphite by intrusive sheets of greenstone, which now lie both above and below the seam. At Glenstrathfarrer, 22 miles from Beauly, Inverness, graphite is found in irregular masses in a micaceous gneiss, intersected by small veins of red granite. It is scaly in character, and sometimes curved and foliated. Material from this locality was sold in 1819 for £93 a ton. Graphite has also been found near the junction of the Deveron with the Bogie, not far from Huntly in Aberdeenshire.

Graphite was worked in 1895 in Talnotry, Newton Stewart, Kirkcudbrightshire. Near the head of Loch Seriden in the Isle of Mull it occurs "in detached masses of a medium quality fit for common uses," near the surface of the soil on the estate of Killimore. It is also met with at Fetlar in the Shetlands and near Kilkenny in Ireland.

Germany.—The only workings in Germany of any importance are in the neighbourhood of Passau in Bavaria. Pressnitz is the centre of the industry, which is of great antiquity, for vessels formed of clay and graphite have been found in graves of prehistoric age in the vicinity of the mines, and Passau crucibles were used by the alchemists. The graphite occurs in 'lenticular masses of highly-decomposed micaceous rock which are found in the hercynian gneiss, near the line of contact with the granitic rocks. The deposits are accompanied on the foot-wall side by beds of syenite and crystalline limestone, both of which contain a certain amount of graphite, and on the hanging wall by intrusions of gabbro.

Weinschenk believes that the great earth movements that at an early period affected the district operated most strongly at

the junction of the unequally-resisting gneiss and limestone, and that the syenite found its way along this line of weakness. Then occurred the great granitic intrusion, followed by gaseous emanations which decomposed the gneiss where it was crushed by earth movements and at the same time deposited the graphite. The gabbro was subsequently intruded, and from it was derived the pyrites which so frequently accompanies the graphite.

Almost everywhere the presence of the graphite is marked by extreme decomposition of the rock, in which the original minerals are almost entirely destroyed and little traces of the structure remain. The gneiss and syenite, which were originally formed largely of alkali felspars and quartz, are converted into aggregates of kaolin (hydrous silicate of alumina), nontronite (hydrous silicate of ferric iron), and "mog," a dark-brown mass of complex composition, consisting of a hydrous silicate containing the higher oxides of manganese, with batavite (hydrous magnesia alumina silicate with a nacreous lustre) and other minerals.

The deposition of the graphite seems to have been an accompaniment of this process. Everywhere it seems to have followed the lines of least resistance, being found in regions of crushing and portions of the rock rich in mica. Under the microscope it is seen to have penetrated between the cleavage planes of the mica, and into the minute crevices that ramify through the rock, and the partings between adjoining minerals.

The graphite, occurring in large flakes, is easily separated by dry processes, a concentrate containing 90 per cent. of carbon being obtained. In this way the pyrites is eliminated, and the chief remaining impurity is mica, which does not affect the value of the graphite for crucibles, the purpose to which the Bavarian output is mainly applied.

The output in metric tons during the six years ending in 1905 was as follows :—

1900 . .	9,248	1903 . .	3,720
1901 . .	4,435	1904 . .	3,784
1902 . .	5,023	1905 . .	4,921

Austria.—The principal deposits of Austria are in Bohemia, in gneisses, granulites, and mica schists on the other side of

the great granitic tract which adjoins the graphite region of Bavaria.

Here also crystalline limestone is met with in the neighbourhood of the graphite, which occurs in more continuous beds than in Bavaria, but is accompanied by the same decomposition products, though in less amount. A line of graphite-bearing rocks extends from Schwarzbach to Krumau. The most valuable deposits are the "fürstlich Schwarzenberg'schen Werke" at Schwarzbach, where three layers are exposed. The centre bed yields the "fett" graphite, a soft earthy variety of such purity that it is placed on the market in its natural state after some small concretion-like aggregates of silicates have been removed by hand. This has a finely-flaky structure, and is employed for pencils. It appears to be closely allied to the Borrowdale graphite. The upper and lower beds consist of compact impure schistose graphite, which is somewhat hard and has a dull fracture, but in places shows a flaky character. At Krumau, where the graphite is still more compact, the beds have a schistose structure and are very friable. In the Bohemian beds pyrites is widely disseminated, and gives rise on weathering to a yellow ferruginous crust at the surface.

The inferior Bohemian graphite which is too impure or compact for use in pencils is ground fine and freed from sulphides and other heavy minerals by the methods already described. The refined material does not contain more than 50 or 60 per cent. of graphite, and is used in the manufacture of inferior crucibles and for stove polish.

Graphite is obtained in Styria in the Rottenmanner Tauern, an eastern spur of the Niedern Tauern, extending from the Oberennsthal by way of the Paltenthal and Liesingthal to Semmering. It occurs as beds or impregnations in chloritoid schists, alternating with true phyllites. In a few localities recognisable vegetable remains have been found which show that the rocks are of carboniferous age. They appear to have been metamorphosed by the intrusion of the central gneissose granite of the Alps. The carbon is completely changed into graphite, and the product has been successfully employed in the same manner as other graphite. The average percentage of carbon is higher than in Bohemia, and though at present the mineral

fetches a less price, it is not really inferior. It is remarkably free from pyrites, which only occurs in aggregates visible to the naked eye, and therefore easily removed. It is employed for covering the interior of moulds, and in the formation of crucibles for melting steel. It occurs in three varieties. The first is rather soft, earthy, black and lustreless, and is met with where there has been considerable earth movement. Under the microscope a few grains of the minerals of the adjoining rock are observed in the finely-divided, dust-like graphite. The second, the "hard graphite," resembles anthracite. It occurs where there has been little movement, and retains the structure and appearance of coal, but its coldness to the touch shows it to be really graphite. The third form is vesicular and coke-like. The vesicles are filled with earthy graphite of great purity. This easily falls out, and the vesicular character, which was previously masked by the uniform black tint, becomes obvious.

Deposits of graphite, which are also supposed to be the result of the metamorphism of vegetable matter, are found in Moravia in the neighbourhood of Altstädt and Goldenstein. Seams of graphite and of gneiss impregnated with graphite are intercalated in crystalline limestones. The metamorphic action is supposed to be due to the action of intrusive sheets of basic rocks now represented by amphibolites. The beds, unlike those of Styria, are supposed to be of præcambrian age. The graphite is concentrated by slime processes, and the product is comparable with the inferior qualities of Bohemian graphite. Graphite is also met with in Lower Austria.

The following table shows the output for Austria in metric tons in the four years ending in 1904:—

1901	29,992	1903	29,590
1902	29,527	1904	28,620

The different political divisions of Austria contributed to the output of graphite in 1904 in the following proportions: Bohemia, 44; Styria, 27; Moravia, 26; Lower Austria, 3 per cent.

Italy.—Graphite is worked in the north-west of Italy near Pinerolo in the Vaudois on the Cottian Alps, and near Bagnasco in the Bormida Valley in the portion of the Maritime Alps

usually referred to as the Ligurian Apennines. These deposits are very similar to those of Styria.

The following is the output of Italian graphite in recent years in metric tons:—

1901	10,313	1903	7,920
1902	9,210	1904	9,765

Graphite has also been worked to some extent in Sweden and Spain, and is found in numerous other localities in Europe where crystalline rocks occur, but the output, except in the cases of Germany, Austria, and Italy, is very small.

Russia in Asia.—There are numerous deposits of graphite in Siberia, but little work is now being carried on. A mine at Batugol near Irkutsk yielded at one time graphite of exceptionally uniform fibrous character and great purity. A thick vein of pure graphite appears to have traversed a granitic or dioritic rock. Large lumps of pure graphite are also said to have occurred in the adjoining metamorphosed limestone. The graphite obtained from this locality was manufactured into pencils of the finest quality.

India.—Graphite is found in many localities in India. The most important deposits are in Travancore State, where it occurs in veins in the granulitic rocks of the charnockite series. Extensive occurrences of graphite are also met with in Godavari, Vizagapatam, and the Central Provinces. A number of specimens from the Kalahandi State and Chhatisgarh District in the Central Provinces were examined in the Scientific and Technical Department of the Imperial Institute (*Bulletin of the Imperial Institute*, 1904, **2**. 232). They occur in a series of garnet sillimanite rocks which overlie the granitoid gneiss. The best sample contained 79·91 per cent. of fixed carbon, 2·61 per cent. of volatile matter, and 16·69 per cent. of ash. It was not sufficiently flaky to be used for crucibles of the best quality. It could, however, be easily concentrated, and would then, like the lower qualities from Bohemia, be available for inferior crucibles used for steel castings.

Graphite is also met with in Afghanistan and the Punjab, and it occurs in crystalline schists in the Kumaun District of the North-West Provinces. It is found under similar

conditions in Darjiling, but contains a very large proportion of ash. Graphite has also been reported from Tenasserim and Upper Burma.

The following table gives the output of India in recent years. The mineral was obtained mainly from Travancore.

Year.	Tons.	£	Year.	Tons.	£
1901	2,490	13,635	1904	3,256	16,726
1902	4,575	24,410	1905	2,324	16,890
1903	3,394	16,970			

Ceylon.—It is from Ceylon that the finest graphite at present mined is obtained. Much information regarding the occurrence of the mineral in Ceylon has been obtained as the result of the work of the Ceylon Mineral Survey now being carried out in connection with the Imperial Institute. The mineral sometimes occurs in small scattered flakes in the granulites allied to the charnockite series of Southern India, and in the crystalline limestones. The deposits of commercial importance are, however, from beds, veins, or nests in the granulite rocks, and are undoubtedly of secondary formation.

Large pockets containing many tons of pure coarsely-flaky graphite alternate with narrow veins branching in all directions through the rock. The crystalline rocks are often altered at the surface, forming a coating of laterite that may be 15 to 18 feet in thickness, in which deposits of graphite are still visible, for the mineral resists to a large extent decomposing influences, but it has lost its lustre, and is of comparatively little value. However, by following it down material of the best quality may be discovered in the solid rock.

The graphite has as a rule a flaky columnar structure. The true lamellar graphite is rare, but occasionally large tabular crystals of graphite occur with a diameter of as much as 8 inches. There is usually a tendency to a radial formation which causes the mineral to break up into three-cornered fragments. Sometimes it becomes so stringy as to be nearly asbestiform, or it may form a compact aggregate with a finely-scaly structure without definite direction.

The coarse prismatic structure usually occurs with a direction at right angles to the walls of the vein, while in the centre there

is a secondary formation of compact mica. Where there has been movement along the vein the fibrous or flaky structure is drawn out more or less parallel to the walls, and in this way the graphite is often rendered completely compact. It is then equal in purity and uniformity of structure to the material formerly obtained from Batugol in Russia. There is in Ceylon little alteration of the adjoining rock by the action of hot water and gases, except in the immediate vicinity of the vein or where a portion of the rock is enveloped in a network of graphite films. In such cases decomposition products are met with similar to those found in Bavaria. Sometimes the adjoining rock is penetrated by scales and flakes of graphite, but not to a greater depth than about half-an-inch.

Most of the pits are small, and sunk by the villagers, without any attempt to determine the direction of the dip of the vein. The shafts are usually rectangular, about 6 feet square, and may reach a depth of 50 to 100 feet. Very primitive winding apparatus is employed. Many mines are only worked when the price of graphite is high. A few mines have been worked on European lines, but not as a rule with much success, as the deposits are irregular and as a rule soon give out, so that it does not pay to go to great expense in development.

The graphite is conveyed from the mine in bags to a dressing-shed, where it is roughly hand-picked. It is then transported in barrels to Colombo, where, after sorting out the larger lumps, it is sized on a series of stationary screens set at a slope of about 35°, and having holes of 10-, 6-, 4-, and 3-sixteenths of an inch in diameter. The coarser impurities are at the same time removed. The clean graphite is polished, while the poorer material is concentrated, either in water or in the dry way by winnowing.

Graphite is graded according to size as "lump," "ordinary chips," "dust," and "flying dust."

New South Wales.—Graphite is met with in numerous localities in New South Wales, but has not yet been worked with much success. At a point five miles east of Undercliff Station and 12 miles from Wilson's Downfall in Buller County, coal of the permocarboniferous period is converted into graphite by the neighbourhood of an intrusive mass of granite. A large

sample was sent to the United States, and was there declared to be suitable for coating moulds and similar purposes.

Graphite has also been mined at a point 26 miles north of Walcha on the sides of a steep spur above Blue Mountain Creek. It occurs in a eurite dyke which is generally micropegmatitic and crowded with spheroidal segregations of graphitic material. The dyke is intrusive in a granite. The spheroidal segregations vary from half to one inch in diameter, and make up from 1 to 50 per cent. of the rock. They contain from 20 to 25 per cent. of graphite.

Victoria.—Graphite is found in a fairly pure state, but only in small amount, in ordovician slates and associated rocks at Kerrie, County Bourke, and near Wood's Point, and graphitic slates of the same age are found in several of the gold-fields.

Queensland.—Graphite is found in Queensland near Maryborough. It occurs in the saddle connecting Mount Bopple on the north and Beacon Peak on the south. Here bituminous coal of carbonaceous age is stated to have been metamorphosed by intrusive igneous rocks, mainly hornblende andesite. It has been converted on the west almost entirely into graphite, while it has been changed on the east to semi-bituminous coal, anthracite, and graphite. In one locality dull earthy graphite is separated by only six inches of graphitic clay from lustrous anthracite below. It is possible, however, that this anthracite may be similar in nature to the Styrian graphite that so closely resembles anthracite. The graphite usually contains much ash, but the best samples yielded 74·1 and 90·9 per cent. of fixed carbon, and 1·10 and 4·4 per cent. respectively of moisture and volatile matter, while the anthracite gave 90·9 per cent. of fixed carbon, and 4·5 per cent. of moisture and volatile matter.

Extensive deposits of graphite are met with in Scrubby Creek in the Mackay District, and numerous other localities in the State.

West Australia.—Graphite has been worked to a limited extent near the head of the Donnelly River.

South Australia.—Graphite has been reported from numerous localities both in South Australia proper and in the Northern Territory; coarse, flaky material is said to have been found at Buckingham.

New Zealand.—Considerable deposits of graphite are stated to occur at Pahawan Bay, Golden Bay, containing 35 to 51·45 per cent. of carbon.

Canada.—Graphite occurs at Cape Breton in Nova Scotia in crystalline limestones, and slates of præcambrian age associated with granitic and syenitic intrusions. The syenites themselves sometimes contain specks of graphite. In these rocks it seems probable that the graphite is of secondary origin, though some of the shaly beds have been mistaken for coal seams. In one locality half-a-mile south of Guthro Lake, near French Vale Road, the graphitic shale has a breadth of two to three feet, and can be traced for some distance along the strike. It contains 38·4 per cent. of graphite. When concentrated it is suitable for lead pencils, electroplating, and other purposes.

Graphite occurs in many other localities in Nova Scotia under similar conditions.

The principal deposits, from an economic standpoint, of New Brunswick are situated near the suspension bridge over the St. John River, connecting the city of the same name with the town of Fairville. Here too the rocks are crystalline limestones and slaty schists of præcambrian age. The graphite occurs at the contact of the limestone and a trap dyke, and is evidently of secondary origin. It occurs in masses of varying thickness. It is associated in places with pyrites, which, however, readily breaks away. The material has a loose slaty structure, parting into somewhat irregular and lenticular fragments, with a greyish-black colour, submetallic lustre, and a black streak. It contains 48·8 per cent. of graphitic carbon. A concentrated sample yielding only 0·16 per cent. of ash was sent to England for a practical test of its value. It was found to be of fair quality, and adapted for the manufacture of the commoner kinds of lead pencils, but was not equal to the Bohemian material. When used in electroplating it did not yield such good results as the graphite ordinarily employed.

It is supposed, however, that certain bands of argillite or slaty schist with disseminated graphite which occur in the same neighbourhood are likely to prove more profitable. The graphite has been concentrated and used for foundry facings and the manufacture of paint.

Beds of graphitic coal occur in devonian rocks in Charlotte County in the same province. The thickness at one place amounts to four feet. It is not of much use as fuel, and its value as graphite has yet to be determined. The coal appears to have been converted into graphite by the intrusion of granite and gabbro.

In the eastern townships of Quebec graphite is finely disseminated in calcareous or argillaceous shales, rendering them soft, unctuous black, and shining. Some of the rocks must be of ordovician or silurian age, as they contain graptolites ; others are known to be devonian. The formation of the graphite is probably due, as in the case of the deposits in Charlotte County, New Brunswick, to the alteration of carbonaceous matter of organic origin by intrusive igneous rocks.

The principal deposits, however, of the province are found in crystalline rocks to the north of Ottawa. Those of commercial value are practically confined to the crystalline limestones and associated greyish and mica gneiss, which form the upper members of the Grenville series. The graphite sometimes occurs in beds or seams, from a few inches to two or three feet in thickness, and often interrupted, thus giving rise to lenticular masses. It also occurs in disseminated flakes in the gneiss and limestones, and in true veins both in a columnar and a foliated condition.

It is especially found in the neighbourhood of granite, pyroxenite, or diabase, which traverse the crystalline limestone and gneiss in all directions. The veins of graphite intersect the igneous rocks as well as the gneiss. In the neighbourhood of these veins the rocks have been decomposed and impregnated with the mineral. This is particularly the case with the crystalline limestone. In the mica gneiss the impregnation is essentially confined to the layers richest in mica, along which the rock breaks easily. The irregular mode of occurrence prevents the profitable exploitation of the mineral on a large scale. The highest percentage of graphite occurs where the graphitic gneisses are cut by dykes. The most persistent deposits are those of disseminated flakes. The percentage of flake in large bodies ranges from 10 to 13 per cent., and in some samples it is over 30 per cent.

The deposits in the Buckingham District have been worked more or less intermittently for forty years. The graphite is separated by slime, float, and dry processes. All these mills operate on the disseminated graphite, especially that in the greyish gneiss.

It has been clearly established that the product obtained from the mills is suitable for all the purposes to which graphite is applied, except fine-pencil making.

In Ontario graphite is found in crystalline rocks of the Grenville series similar to those in which it has been worked in Quebec. The mineral occurs in thin rusty bands of sillimanite gneiss underlying crystalline limestone. No columnar graphite appears to be met with.

The graphite is separated by a dry process, being first roasted in a kiln to dry off the moisture, then crushed in two stages to one-sixteenth of an inch, separated by pneumatic jigs, ground between millstones, and sifted on screens into four grades. The whole process is automatic; the capacity of the mill is one and a half tons an hour, and the yield of graphite about 10 per cent. Graphite occurs in numerous other localities in the province, and in some cases attempts are being made to work the material occurring in veins.

The following statistics show the output of Canadian graphite in recent years :—

Year.	Tons of 2000 lb.	Value. *Dollars.*
1901	2,210	38,780
1902	1,095	28,300
1903	728	23,745
1904	452	11,760
1905	541	17,032

United States.—The most important graphite deposits in the United States are at Ticonderoga, Essex County, New York. There it occurs in a fissure vein in a garnetiferous gneiss, the foliation of which it cuts nearly at right angles. It is also met with in a grey quartzite, interbedded with garnetiferous and micaceous gneiss. The rock contains about 10 per cent. of graphite, but only about half of this is saved.

Graphite is also mined four miles west of Hague on Lake

George, New York, where there are alternating layers of graphite shale or schist forming a bed from 3 to 13 feet in thickness. Garnetiferous sandstones form a strong ledge above and below. It is supposed by Walcott to be metamorphosed coal. The graphite of Newport, Rhode Island, appears undoubtedly to consist of coal of carboniferous age, metamorphosed into graphite. It contains as much as 55 per cent. of graphite, the remainder consisting of siliceous impurities. It has not, however, been worked with much success, though it is stated to be suitable for foundry facings.

The supposed graphite of Michigan and Wisconsin is simply carbonaceous schist containing no graphite.

Mexico.—Compact graphite is found at Sonora in Mexico, where a coal-field of carbonaceous age has been much broken up by trap dykes, which have converted most of the coal into brilliant, but somewhat friable, material containing 3 to 4 per cent. of volatile matter. The change is much more complete than at Newport.

South America.—Graphite is found in Brazil at the Arroyal de Bareiras in Minas Geraes, where it is said to be formed by the alteration of carbonaceous beds; also in Uruguay, Chile, Peru, and Guatemala.

Cape Colony.—Graphite has been found at Prince Albert and Calvinia.

Natal.—A deposit of graphite has been met with in the Impetyini Forest, 20 miles south-west of Harding.

Rhodesia and British Central Africa.—Graphite is found in both these Colonies. In the former it occurs in crumpled graphite schist and in calcite. In the latter it is disseminated along the foliage planes of the gneiss.

British East Africa and Uganda.—Specimens of graphite have been obtained from a pit near the villages of Ajali, north of the Diangbi Hills, Nimule, Nile Province, and from Bukunga in the district of Mugema on the slopes of Ruwenzori, four days south-west from Entebbe, Toro Province. It is also stated that large quantities are met with in the hilly country near Kitana's camp, half-way between Hoima and Butiaba, Unyoro Province. The graphite appears to occur in streaks or veins in gneissose granite and schist, as well as in the

soft, often whitish, laterite or clay produced by the alteration *in situ* of the same rock. The mineral has also been found on the Uganda Railway in quartz.

Graphite schist also occurs in the Bahr-el-Ghazal in the Southern Sudan.

Northern Nigeria.—Decomposed graphite schists have been found in the Protectorate, where it is locally known as "Baki-n-Koli" (black antimony). An analysis made at the Imperial Institute showed it to contain only 5·34 per cent. of carbon and combined water (*Col. Rep., Miscell.*, No. 26, p. 15).

According to *Mineral Industry* for 1905 the world's output of graphite in 1904 in metric tons was as follows :—

Source.	*Tons.*
Austria	28,620
Canada	411
Ceylon	26,478
Germany	3,784
India	3,309
Italy	9,765
Japan	114
Mexico	1,952
Sweden	55
United States	2,045
Total	76,533

Further less detailed statistics for 1900 have been given in this *Bulletin*, 1904, **2.** 103.

Amongst the sources from which the foregoing notes were compiled, the following papers and reports may be mentioned :—

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Akad., Vol. xix. (1898), p. 509; "Die Graphit-lagerstätten des bayerisch-böhmischen Waldgebirges," id. xix. (1898), p. 521; "Alpine Graphit-lagerstätten," id. xxi. (1901), p. 233; and "Die Graphit-lagerstätten der Insel Ceylon," id. xxi. (1901), p. 279.

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GENERAL NOTES.

Coffee Cultivation in Mysore.—In 1902 a Bulletin (No. 11, Department of Agriculture, State of Mysore) was published by Dr. Lehmann, Agricultural Chemist to the State of Mysore, giving some observations on the desirability of "mulching" coffee plants with vegetable débris. As this Bulletin appears to be practically unknown outside India, it may be worth while to call attention to its contents here.

The soil in many coffee plantations in Mysore shows a great tendency to cake and harden on the surface, and it has been the custom to dig it frequently, which temporarily improves its condition, though this operation involves some risk of damaging the roots of the coffee plants. Dr. Lehmann is of opinion that this tendency to cake shown by Mysore soil is due largely to the lack of organic matter and lime, and he suggests as a remedy that dead leaves and other vegetable débris should be allowed to accumulate on the soil, and that digging should not be resorted to. He points out finally that "mulching" in this way would save the cost of digging, improve the mechanical condition of the soil, probably increase the productiveness of the estates after the first year or two, and save a large portion of the expense at present incurred in the purchase of organic manure. The disadvantages of "mulching" are, that it would possibly reduce the output of coffee on estates for a year or two and perhaps increase the risk of fire, but these, Dr. Lehmann considers, are small in comparison with the advantages conferred.

This advocacy of "mulching" for coffee plants is of special interest in connection with the results of similar experiments made by Dr. F. Watts in cocoa plantations in the West Indies (*Bulletin of the Imperial Institute,* 1906, **4.** 351).

In connection with the foregoing it is of interest to mention that two samples of coffee grown in Mysore have been received at the Imperial Institute recently for investigation. The first consisted of coffee produced on the Arabidecool Estate without manuring, and the second, of coffee grown on the same estate in the subsequent year, and after the application of a manurial mixture composed of basic slag, saltpetre, and "poonac." This had the effect of greatly improving the appearance of the plants and of increasing the yield of coffee per acre, and it was especially desired to ascertain what effect, if any, had been produced in the composition and quality of the coffee berries as the result of the manurial treatment. The results of a physical examination of the berries showed that those collected from manured plants were of higher specific gravity, larger, and heavier than those obtained from the unmanured plants. Similarly, whilst the first sample from unmanured plants contained only 1·22 per cent. of "total alkaloid" (chiefly caffeine), that from the manured plants contained 1·46 per cent. The coffee from the manured plants was sold at 55 shillings per cwt., whereas that from the unmanured plants in the previous year realised 52 shillings per cwt. It is clear from these results that the manurial treatment has had the effect of giving a better yield of heavier and larger beans, which are richer in alkaloid; but the full effect is probably not seen in the first crop taken after the application of the manure, and an examination of the next crop will probably give more trustworthy information on this point.

Utilisation of the Soy Bean.—The plant yielding the "soy bean" (*Glycine soja*) has of late received much attention at the hands of agriculturists in tropical countries on account of its value as a green manure (*Bulletin of the Imperial Institute*, 1906, **4**. 123). The bean itself has long been employed in the East as a vegetable and food-stuff, and has been imported in large quantities into European countries, principally for use as a feeding-stuff for animals. It is also an important ingredient in Indian soy, which forms the basis of chutney. More recently the introduction of cheaper methods for the extraction of fixed oils by the use of solvents has made it possible to utilise such materials as the soy bean, which contains only 10 per cent. of fixed oil, as a source of oil, and considerable quantities are now used in the United Kingdom in this way. In Japan some attention is at present being paid by physiologists and others to the native food-stuffs, and to the discovery of better methods of preparing these for use, and as the soy bean is largely grown and consumed there, this product has been the subject of some investigation. In the *Bulletin of the Japanese College of Agriculture at Tokyo* (1906, **7**. No. 1) it is pointed out that when these beans, previously softened by soaking in water, are ground to a thin paste with water, and this mixture is boiled, a highly-nutritious liquid is produced, which contains about 93 per cent. of water, with about 3·02 per cent. of proteid, 2·13 per cent. of fat, and nearly 2 per cent. of carbohydrates. This

material can be preserved in a concentrated form by adding sugar and evaporating to a syrupy consistence. In this condition it is said to have a pleasant taste and a faint odour of beans, and to be suitable for mixing with tea or coffee in place of milk.

From this product the chief proteid constituent, glycinin, can be precipitated by the addition of either calcium or magnesium salts, and this material is being used in Japan as a food-stuff under the name "tofu." It is capable, like the precipitated casein of milk, of undergoing fermentation, producing a vegetable cheese differing very little in flavour from ordinary cheese.

Cocoa Cultivation in Tobago.—The Imperial Department of Agriculture for the West Indies has recently issued a pamphlet entitled, *Tobago: Hints to Settlers*, in which a large amount of general information is given regarding the natural features, the products, and the resources of the island.

The most promising industry at the present time is cocoa, which is grown on a few large estates, and also by large numbers of peasant proprietors, owners of small areas of Crown lands. Very full estimates are given in two appendices of the expenses and returns in cocoa cultivation. Both estimates deal with the problem of bringing 100 acres of forest land into full bearing under this crop; in one case the most advantageous method of using a capital of £2,000, and in the second case a capital of £3,000, is discussed. The tables show that the possession of the extra £1,000 is very advantageous, as it enables more land to be brought into cultivation at an early period. Thus whereas the one planter can only afford to clear fifteen acres in the first year, the other can clear twenty-five acres. Both can plant up ten or more acres each succeeding year, and by the seventeenth year, when both would have all their land in full bearing, the man with £2,000 capital originally would be in receipt of a net income of about £700 annually, whilst the other planter would enjoy a net income of £1,000 per annum.

The planting of Central American rubber trees (*Castilloa elastica*) with the cocoa is advocated. It has been found that with about seventy rubber trees to the acre a yield of about half-a-pound of rubber per tree is obtained after the eighth year without any effect on the cocoa crop. Rubber from eight-year-old trees has sold at 4*s*. to 5*s*. per lb., and this crop should yield an additional return of £6 to £7 per acre.

New South Wales Railway Timbers.—In this *Bulletin* (1904, **2**. 119) a general account was given of the timbers of the State, with especial reference to those exhibited in the New South Wales Court of the Imperial Institute. More recently a report has been issued on the *Suitability of New South Wales Timbers for Railway Construction*, compiled by the Chief Forester, and published by the Government for the information of the Government of India. Notes are given on the characters, uses, distribution, and supply available of twenty-four

timbers employed in railway construction in the State. Information is also afforded as to results of technical tests and trials.

The various kinds of Ironbark (*E. paniculata*, *E. crebra*, *E. siderophloia*, and *E. sideroxylon*) are placed first in point of strength and durability. They are extensively used for bridges, culverts, railway sleepers, fencing posts; also in carriage and wagon building. Although largely worked in the more accessible localities the quantity still available is stated to be large.

The export trade of New South Wales woods is now of the annual value of about £150,000, chiefly to New Zealand, but the United Kingdom, Germany, South Africa, the United States, and Fiji also obtain some timber from this source.

The Bamboos of Fokein.—The report on the Hong Kong Botanical and Forestry Department for 1905 contains an account of an expedition sent by the Government, in charge of the Superintendent of the Department, to investigate the botanical resources of the Province of Fokein. Previous to the date of the expedition little was known of the flora of the Province, but as a result of the exploration of the country immediately surrounding the navigable parts of the Yuen Fu and Min Rivers, some 700 species were collected and information obtained on the more important industries carried on by the Chinese.

In the steep gorges and on the sides of mountain valleys bamboo is extensively cultivated. Bamboo paper, sold in large quantities in Southern China, and used by the Chinese for wrapping up parcels, is manufactured at Buong Kang. The bamboo used is a species of *Phyllostachys*, which grows from 20 to 50 feet high, and has a downy stem when young. To prepare the paper the stems are cut into convenient lengths and placed in concrete tanks of water for about four months. After that period, as they become fit, the stems are removed by hand and reduced to pulp in a water mill. The mill used by the Chinese for all purposes of pounding consists of an overshot wheel to the axle of which a wooden cam is attached, which alternately raises and releases the pounder. The pulp produced by pounding the stems consists of a fibrous mass, the fragments being about one inch long. It is taken to the factory and there mixed with water containing some binding ingredient or size derived from leaves of various plants, among which was an Actinidia, a Holly, a species of Lauraceæ, and a Schizandra. The fibre is removed from this liquid on a delicate tray made of bamboo threads supported on a bamboo frame. Each film so removed forms a sheet of paper, it being only necessary to dry it on a hot surface and press it in a strong lever press to render it ready for market.

The following sixteen kinds of bamboo are recognised in the Yengping Mountains:—

1. Ma Deuk (*Phyllostachys*, sp.). The commonest species, 20 to 50 feet high. Used for small buildings, and for

making paper and mats. The young shoots are eaten. Planted from cuttings in the spring, it remains for about three years before the shoots develop. Flowering is said to occur every five years.

2. Ku Deuk (*Phyllostachys nigra*, Munro). The Bitter Bamboo. The bitter shoots are eaten.
3. Gong Nong Deuk (*Phyllostachys nigra*, Munro). Used for boat and chair poles.
4. Cieh Deuk (*Phyllostachys nigra*, Munro). The Folding Bamboo. Shoots dried for export.
5. Uong Deuk (*Bambusa*, sp.). The Yellow Bamboo. A small variety planted for hedges.
6. Lek Deuk (*Bambusa pallida*, Munro). The Clustered Bamboo. A decorative species with remarkably long internodes.
7. Sioh Deuk (*Phyllostachys nigra*, Munro). The Stone Bamboo. Used for basket-making. Basket-making is an important industry, and bamboo baskets are widely used and extremely cheap in the Province.
8. U Deuk (*Phyllostachys nigra*, Munro). The Black Bamboo. Used for making umbrella handles.
9. Hueng Deuk (*Bambusa quadrangularis*, Fenzi). The Square Bamboo. Used for walking-sticks.
10. Ming Deuk (*Phyllostachys nigra*, Munro). A small bamboo with blotched purple and yellow stems. Little used.
11. Lu Deuk, so called, is a large herbaceous grass.
12. Cieng Deuk (*Arundinaria sinica*, Hance). Used for making sieves. The leaves, which are remarkably broad, are in common use for wrapping up food.
13. Long Deuk (*Phyllostachys nigra*, Munro). Edible shoots.
14. Dang Deuk (*Phyllostachys nigra*, Munro).
15. Man or Tsung Deuk (*Phyllostachys nigra*, Munro).
16. Mieng Deuk. Used for making bamboo ropes, which are wonderfully strong and fray-resisting. Used in hauling boats up rapids on the Min River.

Bars in Ostrich Feathers.—Over the whole of the ostrich-farming section of South Africa, but in varying degrees in different localities and in different years in the same locality, imperfections known as "bars" occur in the feathers. The bars are due to local deficiencies of the material composing the feather. They commonly, but not always, extend across the feather at one level as narrow bands, and several bars may occur on one feather. On an individual bird all the feathers, or only a few, may be affected. The presence of these bars considerably diminishes the value of the feathers, especially in the higher grades.

Feathers which should be worth £20 per lb. may, as the result of bars be worth only £10, but from 20 to 25 per cent. appears to be the average depreciation. The annual value of the export of feathers from Cape Colony is over £1,000,000, and the loss to the ostrich farms of the Colony from this cause probably reaches £250,000. The serious character of this trouble has directed the attention of Prof. J. E. Duerden, of Rhodes University College, Grahamstown, to the subject, and a preliminary paper by him appeared in the *Cape of Good Hope Agricultural Journal* for May 1906. He describes the mode of formation of a bird's feather, brings forward evidence to show "that the imperfection is due to some irregularity in the blood supply or nutrition of the feather germ, so that a smaller number of feather cells are formed, thereby giving rise to a constriction or defect at that place; in other words, there is a temporary check in the normal growth of the feather." The time taken for a feather to develop is comparatively long—four to five months—and during this period there is ample opportunity for several variations in the condition of the bird. Barring has not yet been induced experimentally in the feathers of the ostrich, but other investigators have obtained it in profusion in ring-doves, alternately fed and starved during the period when their feathers were developing. It is also reported that at an ostrich farm in California the irregularity occurs in birds insufficiently fed, but not in birds provided with an abundance of food. Incidentally, reference is made to constriction in horns, thin zones in nails, teeth, wool, and other malformations in epidermal structures (as feathers are) usually correlated with mal-nutrition, or poor condition, of the animal. In the ostrich this mal-nutrition may be associated with insufficiency of food, internal or external parasites, or some constitutional defect, and further investigations are to be made to trace the evil to its ultimate cause. Meanwhile, the practical measures advocated are to maintain the birds in good condition, to keep them free from parasites, and to breed from individuals in which the defect is least marked.

New Sources of Nitrogenous Manures.—Recently several new nitrogen compounds suitable for agricultural application have been commercially manufactured. The substance known as "cyanamide" is being manufactured in Germany, and is said to find a ready market. Its formation is due to the absorption of the nitrogen of the air by calcium carbide, and its manurial value is described as about equal to that of sulphate of ammonia. Professor Berkeland and Mr. Eyde have also applied practically a process for converting the nitrogen of the atmosphere into nitrogen oxides by means of the electric arc, and the subsequent preparation of nitrate of calcium from these oxides.

A new process for the production of nitrates has recently been suggested by Messrs. Muntz and Laine, in which advantage is taken of the power possessed by certain bacteria of rapidly converting ammonium compounds into nitrates and nitrites, if a suitable basis for their activity

is provided. Peat in varying stages of decomposition has been experimented with by these investigators, and it was found that if peat is broken up and mixed with lime it forms an excellent material for the cultivation and activity of such nitrifying organisms. If such a peat contact bed, containing the necessary organisms, is saturated with a dilute solution of ammonium sulphate, extremely rapid nitrification takes place.

The best peat for the purpose is the light and spongy variety, probably because it allows a more complete circulation of the air throughout the bed. The nitrifying organisms remain on the peat, and retain their activity as long as they are supplied with ammonium sulphate. As the ammoniacal solution drains slowly through the peat it becomes nitrified, the nitric acid is converted into nitrate of calcium, and this is recovered from the liquid, which drains off, by evaporation.

Nitrification was found to proceed in strong solutions containing up to 22 per cent. of nitrates, so that, by repeatedly passing the liquid through the peat, strong solutions are eventually obtained which can be economically concentrated. So long, however, as the sulphate of ammonia has to be bought, the process can never become a commercial success. Thus the investigators were led to experiment on the possibility of obtaining the original nitrogen from the peat itself. They found that by heating the peat in a current of superheated steam, 1·6 to 1·8 per cent. of nitrogen in the form of ammonia could be obtained from peat containing 2·03 per cent. of nitrogen.

Nitrate Industry.—In the *Journal of the Board of Agriculture* for November 1906 some interesting particulars are given relating to the nitrate industry of Chili.

During recent years there has been a great increase in the consumption of nitrate of soda for agricultural purposes. In 1896 the world's consumption was 1,066,220 tons, but in 1905 this had risen to 1,543,120 tons, an increase of almost 50 per cent.

Practically all the natural nitrate of soda is obtained in the northern portion of the Republic of Chili, a district which is without rain all the year round. In any other circumstances it would be impossible for large deposits of a soluble substance like nitrate of soda to accumulate. The nitrate is found in deposits varying in thickness from one to twelve feet, at a depth from the surface of from four to twelve feet. Access is obtained to the nitrate deposit (known as "caliche") by removing the earth and upper detritus by blasting. The caliche is then loaded into wagons and conveyed to factories, where the salt is purified by crystallisation, as, besides sodium nitrate, other substances are also present in small quantities, the valuable substances iodine and bromine, for example, being obtained as by-products.

The exportation of this product commenced about 1830. In 1840–1844 the amount annually sent abroad was approximately 14,640 tons; in 1874 this had increased to 219,125 tons, and in 1880–1884 to 444,185

tons. At this time, however, such a supply was in excess of the demand, and the prices fell. A company was then formed to regulate the production, but efforts in this direction were not successful until 1900, when the present understanding was agreed to, until March 1909, by the factories concerned.

The production for the current year is fixed at 1,960,000 tons. There has been a gradual rise in the price of nitrate from 7*s.* 9*d.* per cwt. in 1896 to 10*s.* 5*d.* per cwt. in 1905.

Mineral Exploration in Egypt.—Some interesting mineral prospecting work has been done recently in the Dakhla and Khargeh oases of Western Middle Egypt, where mining concessions have been leased to a private company. In the Dakhla oasis extensive alum beds have been located, and these have been worked to some extent during the year, a crude alum which contains some nickel and cobalt being prepared by leaching the raw material. A bed of magnesium sulphate (Epsom salts) has also been located, and some preliminary work on this raw material has been carried out, over 400 tons of fairly pure magnesium sulphate having been prepared. In the same district, extensive deposits of phosphates suitable for use as manures, and of ochres, which may be of value as pigments, are recorded. A similar deposit of red ochre, estimated to be capable of yielding 100,000 cubic yards of workable material, has also been found in the Khargeh oasis at Jebel Ter.

Iron pyrites has been found in fairly large quantities about fifteen miles south of Beris, but the extent of this deposit has not yet been fully determined, owing to the lack of proper appliances.

In the course of boring operations in this district beds of lignite have been met with. Another material of interest which has been found is clay, suitable for the manufacture of tiles, and coloured pots of various kinds, and the qualities of which have been favourably reported on by ceramic experts.

Origin of Cleveland Ironstone.—In a paper contributed recently to the Yorkshire Naturalists' Union, at the Gainsborough meeting of that society, Dr. Sorby gives an explanation of the origin of the Cleveland ironstone. After referring to the well-known fact that the shell forms which occur in the limestone, and were originally calcium carbonate, now consist of carbonate of iron, and that the oölitic grains are similarly altered, he suggests that the Cleveland ironstone now occupies the space of a former oölitic limestone, which was interstratified with clays containing a large amount of organic matter and oxides of iron, and by interaction gave rise to a solution of bicarbonate of iron. This solution percolated through the limestone and reacted with it, the calcium being replaced by iron. The amount of iron in the associated non-calcareous beds would, the author thinks, be quite adequate to supply that now found in the ironstone.

In order to test the validity of this hypothesis, experiments on the conditions of replacement of calcium by iron were made by heating mixtures of crystals of calcite and ferrous chloride in a sealed tube. When such mixtures were maintained at 300° F. for a few weeks, replacement was rapid and pseudomorphs were formed, as hard as any similar mineral product. At 212° F. the action was much slower, whilst at the ordinary temperature, after the lapse of thirty-six years, although the amount of replacement was small, a microscopic examination of a section of a pseudomorph indicated that it had the same sort of structure as that seen in the partially-changed shells of the ironstone.

Platinum in New Zealand.—In addition to the information already given in this *Bulletin* (1906, **4**. 167) on the occurrence of platinum, mention may be made of a discovery of platinum-bearing veins, which may prove to be of considerable commercial importance, in the Hokitika District of New Zealand, by officers of the Geological Survey, and which is recorded in Bulletin No. 1 of the Survey.

The platinum occurs in quartz veins close to the Pounamu belt of magnesian eruptive rocks. This mode of occurrence is of geological interest, as the metal, when found in its native locus, usually occurs actually in the magnesian eruptive rocks.

The only recorded occurrence of platinum in quartz in New Zealand was observed by Mr. J. A. Pond (*Trans. New Zealand Inst.*, 1882), who isolated gold, silver, platinum, and iridium from quartz obtained at a depth of from 540 to 600 feet in the "Queen of Beauty Shaft" at Thames, N.Z.

Platinum has been found in the present case in two reefs, the most important of these being that known as Harley's Creek, where the white semi-vitreous platiniferous quartz occurs in lenticular veins intercalated with the country rock, which consists of a dark shaly phyllite. Assays of two samples of this quartz yielded the following results:—

1.	Platinum:	3	dwts.	8	grs.	Silver:	1 oz.	4	dwts.	9	grs. *per ton.*
2.	,,	1	,,	2	,,	,,		7	,,	13	,, ,, ,,

The second locality is Taipo Gorge Reef, where the platinum occurs in a bedded quartz vein, which attains a maximum width of about one foot, and is enclosed in banded schists. The vein contains a small amount of pyrite and chalcopyrite. The assay of a sample of the quartz from this reef showed the presence of platinum, 1 dwt., and silver, 6 dwt. per ton, but no gold.

The physical condition of the metals in the above samples has not yet been determined, but it is interesting to note that in each case the silver accompanies the platinum in the ratio of 7 to 1, suggesting a combination of the two metals. Only in one of the three samples assayed does the platinum occur in paying quantities, and in this case the vein is small.

It is suggested that prospecting for platiniferous veins might be carried out from the head-waters of Harley's Creek in a south-westerly direction as far as Griffin Creek.

NOTICES OF RECENT LITERATURE.

NEW BOOKS.

OUR EMPIRE, PAST AND PRESENT: VOL. I. GREAT BRITAIN IN EUROPE. By the Earl of Meath, M. H. Cornwall Legh, LL.A., and Edith Jackson. Second edition. Pp. 417, with portraits, illustrations, and maps. (London: Harrison & Sons, 1906.)

The object of this work is to give, within moderate compass, a connected account of the rise, progress, and present position of the British Empire which will serve to increase popular knowledge of this important subject, both at home and in the Colonies, and to stimulate interest in the many Imperial questions which are now arising.

The subject is treated in three volumes, each of which is complete in itself—I. "Great Britain in Europe," II. "Great Britain in Asia," and III. "Great Britain in Africa, America, and Australasia." The second volume, "Great Britain in Asia," has been noticed already in these columns (*Bulletin of the Imperial Institute*, 1905, 4. 80), and a short account may, therefore, be given of the contents of Vol. I., a second edition of which has recently appeared.

"Great Britain in Europe" deals principally with the development of the Mother Country, and is, therefore, mainly historical in character. A short sketch is given of the growth of freedom and good government in England, and three chapters are devoted to an account of the events which determined the union of England, Wales, Scotland, and Ireland to form the United Kingdom.

Prominence is given throughout to the gradual establishment of our oversea possessions, from 1497, when John Cabot hoisted the flag of Henry VII. on the shores of Newfoundland, to the present day. The growth of Britain's sea-power, to which the Empire owes its origin and on which its maintenance depends, is the subject of two interesting chapters which form a concise summary of the glorious records of the British Navy from the year 875, when King Alfred defeated the Danish Vikings "in Swannage Bay," to the construction of the present *Dreadnought*.

The remainder of the book (pp. 291–416) is occupied by descriptions of the Isle of Man, the Channel Islands, and the British possessions in the Mediterranean, viz. Gibraltar, Malta, and Cyprus, the latter included in this volume for convenience. An account is given of each o these, with particulars of the manner in which they

came into our possession, their subsequent history, and their commercial and strategic importance to the Empire.

IMMIGRATION AND ITS EFFECTS UPON THE UNITED STATES. By Prescott F. Hall. Pp. xiii + 393. (New York: Henry Holt & Co., 1906.)

This book is the first of a series entitled "American Public Problems," each volume of which is to be devoted to one single and definite question of wide-spread public interest in American political, economic, and social affairs.

Some idea of the importance of this subject may be gathered from the fact that between 1821 and 1905 nearly 23,000,000 immigrants entered the United States, "a movement of population unprecedented in history." Moreover, the increase in the last few years has been enormous.

The author traces the history and the causes, and discusses the racial, economic, and social conditions of immigration.

The second part of the book is devoted to consideration of its effects. As in the preceding portion, racial, economic, and social questions are considered separately, as far as possible, and it is shown that the naturalised foreigner affects the national life in innumerable ways; decline of the birth rate amongst the Americans, congestion in cities, the more rapid opening up of new territories being amongst the results attributed to this cause.

The laws regulating immigration are considered in detail, their effects traced, and proposals for their improvement discussed. The concluding part (iv.) is devoted to the history of Chinese immigration and the Exclusion Act. Statistical matter and the text of the immigration laws are given in the appendices. The book is of great interest as affording a comprehensive survey of a question of vital importance to the national life of the United States.

WHAT I SAW IN THE TROPICS. By Henry C. Pearson, editor of the *India Rubber World*. Pp. 288, with illustrations. (New York: The India Rubber Publishing Co. London: Arthur H. Wheeler & Co., Temple Avenue, E.C., 1906.)

The interest which has been taken recently by rubber manufacturers and the general public in the establishment of rubber plantations in various parts of the tropics induced the editor of the New York *India Rubber World* to undertake a series of tours to the chief centres of rubber planting, and the volume under notice contains the letters which he forwarded to his journal giving his impressions of the prospects of the industry in the different countries concerned. Mr. Pearson has visited Ceylon, the Straits Settlements, and the Federated Malay States in order to inspect the plantations of Para rubber trees which have been formed there, and has also travelled in many of the States of Central America where *Castilloa elastica* is being cultivated, the letters

including descriptions of journeys in Mexico, Nicaragua, Costa Rica, Panama, and Colombia, and also of visits to Jamaica and Hawaii.

The book is a record of the personal experiences of the author, and makes no claim to be a scientific treatise on rubber cultivation, although many points of interest to planters are discussed in the course of the narrative. The information recorded regarding the prospects of rubber cultivation in some of the Central American States will be of value to all interested in the industry in these countries.

The numerous illustrations, reproduced from photographs, are a feature of the book, and furnish good representations of typical rubber plantations in the Old and New Worlds.

WOBURN EXPERIMENTAL FRUIT FARM. Sixth Report by the Duke of Bedford, K.G., and S. U. Pickering, F.R.S. Pp. 235 + v. (London: Eyre & Spottiswoode, 1906.)

This report deals principally with remedial agents to be employed in destroying the eggs of the pest commonly known as the "mussel scale," owing to the resemblance it bears to a minute mussel shell. In Canada it is known as the "oyster-shell bark louse," and the latter name has also been adopted by the Board of Agriculture in this country. The scientific nomenclature of the insect is equally confusing; it was at first called *Mytilaspis pomorum*, but has now been re-christened *Lepidosaphes ulmi*. The insect itself dies off in the late autumn, leaving the scale it has produced, enclosing the eggs, which, under normal conditions, will hatch out early in the succeeding summer. The experiments undertaken at Woburn have had for their object the discovery of a cheap and efficient agent which could be used as a winter dressing to destroy the eggs of the parasite, and, at the same time, kill the mosses and lichens which infest the trees.

The efficiency of solutions of the caustic alkalis, alkali carbonates, or soap have been tried separately and in combination, spraying experiments have been conducted with water or soap and caustic soda solutions, and, finally, the effect of such potent agents as "Bordeaux mixture" and lead arsenate has been investigated.

It is an easy matter to give in such a paragraph as the foregoing an idea of the scope of the work recently carried out at the Woburn Experimental Station, and recorded in this report, but it is more difficult to convey a notion of the forethought and detailed attention which has evidently been expended in working out every phase of the subject.

The curious observation is recorded that, although a dilute preparation of caustic soda, soap, or petroleum used alone is comparatively inefficient in destroying mussel scale eggs, these three insecticides in combination are remarkably effective, and an aqueous emulsion containing all three is recommended as a dressing for fruit trees affected by this pest.

The preparation of such an emulsion is, however, not such a simple matter as might be supposed, and a considerable amount of time had to be expended by the authors in experimental work before they were in a position to give advice as to the best kind of commercial petroleum to employ, and the methods to be adopted in making the emulsion and applying it.

In the last section of the report an account is given of some preliminary work, which confirms Percival's view that the silver-leaf disease of plum trees is produced by the fungus *Sternoum purpureum.*

Although this work has been undertaken mainly for the benefit of the fruit grower in the United Kingdom, the results are no doubt applicable to the treatment of the similar diseases of tropical crops, and the report is therefore of interest to all who are engaged in agricultural work in the tropical possessions of this country.

WESTERN AUSTRALIA. The Handbook of Horticulture and Viticulture. Second edition. By A. Despeissis. Pp. 620. (Perth: The Government Printer.)

A comprehensive handbook dealing with the subjects within its scope in a practical manner and with special reference to local conditions. After discussing the possibilities of Western Australia as a fruit-growing country, directions are given for clearing and preparing land for planting; drainage, shelter, fencing, pruning, grafting, etc., are then dealt with, the proper method of putting the advice into practice being indicated, as far as possible, by illustrations. The fruits suited to the country are enumerated and described. Other topics dealt with include the gathering, drying, canning, and marketing of fruit, the oversea trade, wine-making, and finally, pests, both insect and fungoid.

The volume will no doubt be appreciated in the State, and should be of use to those desirous of becoming acquainted with the horticultural resources of Western Australia.

AGRICULTURE IN OTHER LANDS. By J. A. Kinsella. Pp. 90. (New Zealand Department of Agriculture. 1906.)

The author, who is the Dairy Commissioner of the New Zealand Department of Agriculture, records in this copiously illustrated series of reports the results of his investigations into agricultural and especially dairying matters in Great Britain, Denmark, Canada, South Africa, and the Argentine Republic.

As an instance of the practical character of the report, Mr. Kinsella, after stating that in his opinion a large and lasting trade between New Zealand and South Africa is almost assured, proceeds to take one by one the principal articles New Zealand has to export and to describe for each the special requirements of the South African market.

MANUAL OF THE NEW ZEALAND FLORA. By T. F. Cheeseman, F.L.S., F.Z.S., Curator of the Auckland Museum. Pp. xxxvi + 199. (Published under the authority of the Government of New Zealand Wellington, 1906.)

During the forty-two years which have passed since Sir J. D. Hooker published the first part of his *Handbook of the New Zealand Flora* great additions have been made to our knowledge of the plants of this most interesting botanical region. The late Mr. T. Kirk, well known for his researches into the botany of the country, collected materials for a complete flora, and in 1894 was commissioned by the Government to prepare a *Students' Flora of New Zealand*. At his death, three years later, some two-fifths only of the work had been completed; this has since been published, only to emphasise the need of a complete account, and in 1900 the Government entrusted this work to Mr. T. F. Cheeseman, Curator of the Auckland Museum.

The author has included the plants of the Kermadec, Chatham, Auckland, Campbell, and Antipodes Islands, and also of Macquarie Island, politically a dependency of Tasmania. Of the major portion of the book it is unnecessary to say more than that it contains a description, with notes on the geographical and altitudinal range, of the 1,571 plants which constitute the indigenous flora of the region. Notes on matters of general scientific or economic interest are added when called for. The New Zealand flora is of a very extraordinary character; thus no less than 1,143 plants, or about three-quarters of the whole flora, are endemic, *i.e.* confined to these islands. Compositæ are much in evidence, forming the high proportion of one-seventh of the total number of native plants.

The vegetation of New Zealand has another interest, diametrically opposed to that attaching to its endemic plants. The country has afforded one of, if not the most, remarkable example of invasion by alien plants. At the present time it is estimated that there are about 600 plant aliens, mostly of European origin, naturalised in the country, and in places the natural flora has been almost supplanted. Mr. Cheeseman records in an appendix a list of these immigrants which have established their footing.

Another appendix contains the Maori names and their botanical equivalents. The history of botanical discovery in New Zealand, commencing with Captain Cook's first visit in 1769, forms the introduction to a most interesting volume.

CONTRIBUTIONS FROM THE UNITED STATES NATIONAL HERBARIUM. VOL. XI. FLORA OF THE STATE OF WASHINGTON. By Charles V. Piper. Pp. 637. (Washington: Government Printing Office, 1906.)

The greater part of the volume is devoted to an annotated catalogue of the vascular plants of Washington State, and gives the botanical and common names, typical habitat, geographical range, zonal distribution, and list of specimens examined of each of the species enumerated.

The author divides the State into seven regions, briefly sketches their physiographic characteristics and meteorological conditions. The zonal distribution of Washington plants is next discussed. This is the most interesting portion of the volume, the value of the descriptive accounts being greatly enhanced by the excellent illustrations of typical "plant formations"; of economic interest are those of forests of Yellow Pine (*Pinus ponderosa*), Hemlock (*Tsuga heterophylla*), giant cedars (*Thuja plicata*), and prairie regions.

The book affords a comprehensive survey of the flora of this region of North America.

FAUNA OF BRITISH INDIA. COLEOPTERA. VOL. I. (CERAMBYCIDÆ). By C. J. Gahan. Pp. xviii + 329. (London: Taylor & Francis, 1906.)

From the title it will be observed that this is the first of a series of volumes on the beetles of British India, with which is included Ceylon. The family of the Cerambycidæ with the Lamiidæ constitute the Longicornes, an extensive group of beetles characteristic of tropical forests, and distinguished in many cases, especially in the males, by the length of the antennæ, as will be seen in the illustrations of Æolesthes, Animes, and Plocæderus.

The author, who is a worker at the Natural History Museum, divides the family into the subfamilies of Prioninæ, Disteniinæ, Lepturinæ, and Cerambycinæ, the chief feature being the inclusion of the Prioninæ. Of the genera defined, nine are new to science, five or more provide new records for India, and many new species are described.

The information is limited to the diagnoses and habitats of the species, and a type of each genus is figured. No mention is made of the economic importance of the species, but the group contains several well-known forest pests, among them being the "coffee borer" of South India, *Xylotrechus quadrupes; Neocerambyx holosericea*, here referred to the genus Æolesthes, that attacks *sál* trees, and has ravaged the Kulsi teak plantations in Assam; *Ægosoma costipenne* (*lacertosum*), also injurious to teak; and *Xylorrhiza adusta*, that destroys the trees of *Wrightia tinctoria* by girdling the stems and branches.

A TREATISE ON CONCRETE PLAIN AND REINFORCED. By F. W. Taylor, M.E., and S. E. Thompson, S.B. Pp. xxix + 571. (New York: John Wiley & Sons, 1906.)

The preface to this volume states that it is designed for practising engineers and contractors, and also as a text- or reference-book on concrete for engineering students. The detailed and practical manner in which the subject matter is handled renders this book a useful addition to the literature already available on these subjects, and that is especially the case with the chapters on reinforced concrete, in the employment of which great advances have been made in recent years. The utility of the book is enhanced by the numerous tables, which will be found convenient in working out designs of structures. A number

of well-selected examples illustrating the erection of concrete masonry are given. The authors have also secured the co-operation of experts in the treatment of the more specialised parts of the subjects.

REPORT OF THE COMMISSION APPOINTED TO INVESTIGATE THE ZINC RESOURCES OF BRITISH COLUMBIA, AND THE CONDITIONS AFFECTING THEIR EXPLOITATION. Pp. 399, with numerous photographs, plates, and maps. (Ottawa: Mines Branch, Department of the Interior, 1906.)

This report has been prepared by Mr. Walter Renton Ingalls, well known as the editor of the *Engineering and Mining Journal.* He was assisted in the examination of the developed mines by Mr. Philip Argall, of Denver, Colorado, and Mr. A. C. Gardé, of Nelson, British Columbia, while Dr. A. E. Barlow and Mr. Joseph Keele, of the Canadian Geological Survey, investigated the undeveloped deposits.

This substantial volume is not merely a valuable and exhaustive account of the zinc deposits and resources of Western Canada, but contains a readable and instructive discussion of the whole subject of the mining and smelting of the metal, and of the markets which are open to the producer.

The chief characteristic of the ore of the Slocan District, where work is at present mainly carried on, is the presence of silver, and the metallurgical aspects of this fact are carefully considered. Special attention, too, is given to the electro-magnetic methods for separating the zinc ores from those containing iron, and nowhere is the subject of electro-magnetic classification better discussed or more amply illustrated.

The report forms an invaluable handbook for the mining industry of the Province, and will be welcomed by all who are interested in the mining and metallurgy of the zinc.

NEW ZEALAND COLONIAL MUSEUM. Bulletin No. 1. Pp. 71. (Wellington: Government Printer, 1906.)

The Colonial Museum, associated since 1867 with the New Zealand Institute, has recently been made a separate institution under the charge of the Colonial Secretary, and Mr. A. Hamilton has been appointed the first Director. One of the principal objects to be attained is the formation of a representative collection illustrative of Maori art and the Maori race. The earnestness of the Government in this matter may be judged from the fact that it is now "unlawful to remove from New Zealand any Maori antiquity without first offering the same for sale to some person authorised on that behalf by the Governor in Council for the benefit of the Colony."

This, the first number of the Bulletin of the museum under the new administration, contains a large number of excellent illustrations, together with descriptive notes, of carvings and weapons purchased by the Government for the museum. "Tokens," in use for currency up to 1860 in New Zealand, form the subject of another paper, whilst the third important subject dealt with is the marine mollusca of the country.

The general appearance of the illustrations and text affords evidence of the high level the printer's art has attained in New Zealand.

ATTI DEL CONGRESSO COLONIALE ITALIANO IN ASMARA. Edited by Carlo Rossetti, General Secretary of the Congress. Vol. i., pp. 378; Vol. ii., pp. 190. (Roma: Tipografia dell Unione Co-operativa Editrice, 1906.)

These two volumes contain the reports presented by members to the Italian Colonial Congress, which was held at Asmara during September and October 1905. These deal mainly with the present position of the Italian Colony of Erythrea, and the problem of its development. In connection with this, the establishment of a colonial school for the education of colonists in tropical agriculture, and similar subjects, is considered. Several articles dealing with the agricultural condition of the country show that, although the scarce or irregular rainfall is a serious drawback to its development, cotton, tobacco, coffee, and other plants can be grown. Of the colonial products exported, the most important are mother-of-pearl, dried skins, resins, and gums. The possibility of establishing a credit bank, means of communication and transport, and the necessity of completing the hydrographic and topographical surveys form the subjects of other reports.

Vol. ii. contains the discussions on the subjects dealt with in the first volume.

NEWFOUNDLAND. Yearbook and Almanac, 1906. Pp. 301. (St. Johns, Newfoundland: The King's Printer.)

This is a useful compilation of the usual type, and contains a large amount of information relative to the public service. The customs tariff, a directory, and much allied matter of interest to residents and others are also included.

The advertisements in black type at the head of each page are confusing in a book of reference, and would be well relegated to a more appropriate position.

THE GUIDE TO SOUTH AFRICA, 1906–7. Edited by A. Samler Brown and G. Gordon Brown for the Union Castle Mail Steamship Co., Ltd. Fourteenth edition. Pp. lxiv + 477. (London: Sampson Low, Marston & Co.)

In noting the twelfth edition of this useful compilation (this *Bulletin*, 1904, **2.** 293) attention was drawn to the comprehensive nature of the contents. The book appeals to many others besides those who find it of use as an actual guidebook. Thus there are summaries on labour in South Africa, irrigation, fruit cultivation, to mention only a few subjects.

The scope of the volume is sufficiently wide to include British Central Africa, Portuguese East Africa, and German South-West Africa.

SANDS AND MACDOUGALL'S SOUTH AUSTRALIAN DIRECTORY, 1906. Pp. 1316.

SANDS AND MACDOUGALL'S MELBOURNE, SUBURBAN, AND COUNTRY DIRECTORY, 1906. Pp. 2076.

These directories contain all the information usually found in such works. Their value can best be tested by constant use, and that these works have successfully passed through this ordeal is demonstrated by the fact that the former is now in its forty-third, and the latter in its fiftieth year.

COLONIAL PUBLICATIONS.

Copies of the following publications descriptive of the resources of British Colonies and Dependencies have recently been received. These are available for distribution at the Central Stand in the Exhibition Galleries, free of charge so long as numbers permit, excepting any to which a price is affixed in the complete list of such publications printed on the covers of this "Bulletin."

A HANDBOOK OF THE BRITISH COLONIAL EMPIRE. By W. H. Mercer, C.M.G., and A. J. Harding. Pp. 202, with a map. (London: Waterlow & Sons, Ltd., 1906.)

The aim of this volume is to afford a comprehensive survey of the British Colonies and Dependencies, exclusive of the Indian Empire.

Part i. is devoted to general topics, such as the extent of the Empire, the classes of possessions, and their mode of acquisition, typical constitutions, mode of administration, legislation, trade, etc.

In the second, and major, part, the Colonies are dealt with in geographical sequence, and full summaries given of their physical and climatic features, products and industries, trade, and general social conditions. The volume, although "unofficial," is based on the *Colonial Office List*, and its authors are respectively one of the Crown agents for the Colonies and a member of the Colonial Office staff. It should be of considerable service to those who desire in a small compass well-summarised and authentic information respecting the British Empire.

NEW SOUTH WALES. Guide for Immigrants and Settlers. Pp. 418. Issued by the Intelligence Department, by authority of the Government. 1906. The object is stated in the preface by the Director of the Intelligence Department to be to give "in a concise form such general information about New South Wales as would be desired by persons proposing to emigrate from the Old World to the State, or needed by an immigrant on arrival with his wife and family." Important subjects have been dealt with in many instances by the responsible officials, *e.g.* the timber

industry, by the Chief Forester; dairying, by the Chief Dairy Expert; the mineral industry, by the Government Geologist, and so on. The net result is a most interesting and, at the same time, authoritative account of "the Mother State of Australia," her products and resources. The book is profusely illustrated, and contains also two maps, one showing the localities of the principal mineral deposits, and the other the areas suited for dairying and intensive cultivation, mixed farming, wheat, sheep, pastoral, and also the limits of the artesian water-bearing basin. One chapter is devoted to the cost of stocking and working a farm, with a brief comparison of Australian and British methods.

SOUVENIR OF THE LAND OF THE GOLDEN WEST. Pp. 33. The agricultural resources of Western Australia are briefly set forth with reference to the interests of intending settlers. Information is also given on the land laws, assisted passages, and other practical matters.

WESTERN AUSTRALIA. Reduced Fares. The official form of application for passages at reduced rates, with copy of regulations.

WESTERN AUSTRALIA: HER LOANS AND WORKS. By W. James, Agent-General. Pp. 34. After a brief review of the history of the State, and of Australian finance, comparison is made between the development of Australia and Canada. The author summarises the mineral and agricultural resources of Western Australia, analyses her loan expenditure, and demonstrates her material prosperity. The paper should be of interest to would-be investors.

WESTERN AUSTRALIA. Selector's Guide to Crown Lands, 1906. Issued by the Minister for Lands. Pp. 83. General information is afforded on climate, the land laws, dairying, farming, fruit-growing, the timber industry, and other matters of practical importance to would-be settlers. The pamphlet is illustrated, and forms a useful general handbook to the State.

LAND AND AGRICULTURE IN BRITISH COLUMBIA. Bureau of Provincial Information, Bulletin No. 10. Pp. 80. 1906. This publication, now in its fifth edition, contains a large amount of information of the character required by the prospective settler. An interesting fact was demonstrated during 1905, namely, that British Columbia fruit could be transported so as to reach the United Kingdom in excellent condition, and it is now stated that many large cattle ranches are being broken up into small farms and orchards, which are being bought by actual settlers. The illustrations are exceptionally good.

THE CANADIAN WEST, ITS PRESENT CONDITION AND FUTURE POSSIBILITIES. Issued by direction of the Minister of the Interior. Ottawa. Pp. 78. A descriptive account of the agricultural possibilities

of Manitoba, Saskatchewan, and Alberta. The rapid development of Winnipeg is emphasised.

AN ENGLISH EMIGRANT'S EXPERIENCE IN WESTERN CANADA. Sketches of life in Alberta, with coloured illustrations.

LIBRARY.—RECENT ADDITIONS.

Books, etc., exclusive of Government Publications, presented to the Library of the Imperial Institute since November 14th, 1906.

A Catalogue of the Aburi Gardens of the Gold Coast . . . . . . By A. E. Evans. (*Institute of Commercial Research in the Tropics.*)

The Handbook of Horticulture and Viticulture of Western Australia . . By A. Despeissis, M.R.A.C. (*Agent-General.*)

Proceedings of the Royal Society of Queensland. Vol. xix., Part II. . . (*Board of International Exchanges.*)

The Third International Congress of Delegated Representatives of Master Cotton Spinners' and Manufacturers' Associations, held at Bremen, June 1906 (*The Committee.*)

Fourth Annual Report of the Rhodesia Museum, Bulawayo, 1905 . . . (*The Director.*)

Proceedings of the Rhodesia Scientific Association. Vol. v., Part III.; Vol. vi., Part I. . . . . . . (*The Council.*)

The Grenada Handbook, Directory, and Almanac for the year 1907 . . . (*Crown Agents for the Colonies.*)

Report on the Dominion Government Expedition to Hudson Bay and the Arctic Islands on board the D.G.S. *Neptune*, 1903–04 . . . . . By A. P. Low, B.Sc., F.R.G.S. (*The Geological Survey of Canada.*)

The Paper Mills Directory of England, Scotland, and Ireland, and Year Book of the Paper-making Trade for 1907 . (*The Editor.*)

Licensing and Temperance in Sweden, Norway, and Denmark . . .	By Edwin A. Pratt. *(The Author, through John Murray.)*
Review of the Frozen Meat Trade, 1906	*(Messrs. Weddel & Co.)*
Mémoires présentés a l'Institut Égyptien. Tome v., Fasc. 1. A Contribution to the study of Mummification in Egypt .	By G. Elliot Smith. *(The Director.)*
Hints to Travellers, Scientific and General	Edited by E. R. Reeves, F.R.A.S., F.R.G.S. *(Royal Geographical Society.)*
Report of the Perth Chamber of Commerce for the year ended 30th June, 1906	*(The Secretary.)*
Illustrated Guide to Adelaide and Environs, 1906	*(The Town Clerk.)*
Die Deutsche Kolonialliteratur im Jahre 1905	By Maximilian Brose. *(Deutsche Kolonial Gesellschaft.)*
Rubber in the East. Peradeniya Manual I.	*(The Director, Botanic Gardens, Ceylon.)*
Delagoa Directory, 1907. A Yearbook of Information Regarding the Port and Town of Lourenço Marques . .	*(Messrs. W. W. Bayly & Co.)*
Natal Civil Service List for 1906.	
Natal Directory for 1907 . . .	*(Agent-General.)*
Transactions of the Royal Society of Edinburgh. Vol. xli., Part III.; Vol. xlv., Part I.	
Proceedings of the Royal Society of Edinburgh. Vol. xxvi., No. VI. 1905–06.	*(The Secretary.)*
Documentary History of Education in Upper Canada. Vol. xv. 1860 . .	By J. G. Hodgins, I.S.O., M.A., LL.D. *(Minister of Education.)*
New South Wales: A Guide for Immigrants and Settlers .	*(Agent-General.)*
Newspaper Press Directory for 1907 .	*(Messrs. C. Mitchell & Co.)*
Rubber Planting in Mexico and Central America	By Pehr Olsson-Seffer, Ph.D. *(The Author.)*
The Lemon-scented Ironbark (*Eucalyptus staigeriana*) and its Essential Oil. .	By R. T. Baker, F.L.S., and H. G. Smith, F.C.S.

On two Species of Eucalyptus from Eastern Australia	By R. T. Baker, F.L.S. (*Technological Museum, Sydney.*)
Annual Report of the Leeds Chamber of Commerce, 1906	(*The Secretary.*)
Tea Culture in Natal	By A. S. L. Hulett.
The "Times of India" Calendar and Directory for 1906	(*India Office.*)
Trinidad and Tobago Yearbook for 1907.	By J. H. Collens. (*The Government Printer.*)
Dr. Schlich's Manual of Forestry. Vol. iv. Forest Protection	By W. R. Fisher, M.A. (*Messrs. Bradbury, Agnew & Co.*)
The Australian Copper Mining Manual, with special notes and map of the North Queensland copper-fields .	(*The Editor of "Critic."*)
Gibraltar Directory and Guide Book for 1907	(*The Colonial Secretary.*)
Énumération des Plantes recoltées par Émile Laurent pendant sa dernière Mission au Congo. Fasc. iv. . .	By E. de Wildeman. (*The Author.*)
Report of the Singapore Chamber of Commerce for the year 1906 . .	(*The Secretary.*)
Analyse des Métaux par Électrolyse .	By A. Hollard, D.Sc., and L. Bertiaux. (*MM. H. Dunod et E. Pinat.*)
Catalogue of the Marathi, Gujarati, Bengali, Assamese, Oriya, Pushtu, and Sindhi Manuscripts in the Library of the British Museum	By J. F. Blumhardt, M.A. (*The Trustees.*)
Auckland University College (University of New Zealand) Calendar for the year 1907	(*The Registrar.*)
Étude Économique sur le Commerce et la Production Agricole de l'Ile de Chypre	By Victor Mosseri. (*The Author.*)

BULLETIN

OF THE

IMPERIAL INSTITUTE

1907. VOL. V. NO. 2.

SCIENTIFIC AND TECHNICAL DEPARTMENT.

RECENT INVESTIGATIONS.

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Indian and Colonial Governments concerned.

FIBRES OF BRITISH WEST AFRICA.

PART II.

(*Continued from page* 10.)

FIBRES SUITABLE FOR THE MANUFACTURE OF CORDAGE.

THERE are several plants in West Africa which yield fibres suitable for the manufacture of rope and twine, among which may be mentioned species of *Agave, Furcræa, Musa* and *Sansevieria.*

Agave species.

In 1890, specimens of the leaves of an *Agave* were received in this country from Sherbro in Sierra Leone, where the plant is known as "Wild Sarsaparilla." These leaves were identified at Kew as those of a form of *Agave rigida* (*Kew Bulletin,* 1892, 36). It is evident, therefore, that at some time or other the Sisal hemp plant has been introduced into West Africa, and it is probable that it would be well adapted to cultivation there since it is capable of growth in dry, arid regions, unsuited to most other plants.

A small sample of Sisal hemp from Sierra Leone examined at the Imperial Institute in the early part of the present year consisted of fairly lustrous fibre which was well cleaned and prepared, and was of fair strength but only 22–27 inches long. The strands or filaments of fibre were finer at one end than the other; the coarser ends were nearly white whilst the finer ends were pale brown.

On chemical examination, this sample yielded the results given in the following table, to which are added for comparison those furnished by samples of Sisal hemp from Trinidad and from the Bahamas which have been examined in the Scientific and Technical Department.

	Sample from Sierra Leone. *Per cent.*	Sisal hemp from Trinidad. *Per cent.*	Sisal hemp from the Bahamas. *Per cent.*
Moisture	9·0	11·6	12·8
Ash	0·8	1·0	4·4
α-Hydrolysis (loss)	9·2	11·7	12·0
β-Hydrolysis (loss)	14·5	13·5	16·1
Acid purification (loss)	0·8	1·0	—
Cellulose	75·4	77·2	75·9

Length of ultimate fibre { 0·9–3·0 mm. or 0·04–0·12 inch

These figures show that the sample is of good quality and in chemical behaviour compares satisfactorily with the specimens from Trinidad and the Bahamas.

The commercial experts reported that the product was a useful fibre. It was very short but of fair colour and good strength. The material was said to be too short for machine spinning and would perhaps be worth £28–£30 per ton, although if it were of the usual length of Sisal hemp (about 4 feet) its value would be £33 per ton and upwards (March 1906).

Furcræa species.

A sample of the fibre of *Furcræa cubensis* from Sierra Leone was examined at the Imperial Institute in 1902 and is described in this *Bulletin* (1903, **1.** 22).

A further specimen received in 1905 consisted of rather badly cleaned, pale brown fibre of poor strength and from three to four feet long. It was stated that the plant from which this fibre was derived is not indigenous to Sierra Leone but was probably introduced from Kew.

The results of the chemical examination of this specimen are given in the following table and are compared with those furnished by the earlier sample referred to above.

	Present Sample. *Per cent.*	Sample received in 1902. *Per cent.*
Moisture	9·1	9·8
Ash	1·0	0·8
a-Hydrolysis (loss)	11·1	13·5
β-Hydrolysis (loss)	16·0	19·1
Acid purification (loss)	2·6	4·1
Cellulose	79·1	75·3
Length of ultimate fibre	1·7–2·8 mm. or 0·07–0·11 inch	1·5–5·0 mm. or 0·06–0·20 inch
Length of staple	3–4 feet	28–29 inches

These figures show that in chemical composition and behaviour the present sample is superior to that previously examined, since it is richer in cellulose and suffers smaller loss on hydrolysis and acid purification. The sample is not so well prepared, however, as the earlier sample and is decidedly weaker.

The commercial experts reported that the fibre was of fair length and colour but was of poor quality, tender, inferior to the fibre of *Furcræa gigantea* (Mauritius hemp), and probably worth £24–£25 per ton.

Musa species.

The genus *Musa* is of great economic importance since it includes the plantain and banana, which have been cultivated in tropical countries from very early times for the sake of their fruits. From the point of view of fibre production the most important species is *Musa textilis*, which yields the well-known

Manila hemp of commerce obtained from the sheathing petioles of the leaves. An account of the Manila hemp industry of the Philippines has been given in this *Bulletin* (1904, **2**. 48). Several other species of *Musa* also yield valuable fibres, some of which have been described in this *Bulletin* (1905, **3**. 226).

Three specimens of plantain or banana fibres derived from *Musa paradisiaca* or *M. sapientum* were forwarded from Sierra Leone in 1902 and are described in the article on p. 22 of vol. 1 of this *Bulletin*. The products were of inferior quality and although this was largely due to defective preparation it was still considered unlikely that these fibres would be of value for any but local uses.

Two small samples of fibre from Nigeria were received at the Imperial Institute in June 1906. No information regarding the botanical source of the fibres was available, but their native names were given as "Nkupup" and "Ndehe Ukom." It was stated that fair quantities of each would be obtainable if a sufficient price could be offered to the natives. The samples, which were labelled 1 and 2, both resembled banana fibre in appearance.

Sample No. 1, "*Nkupup*."—This consisted of buff-coloured, coarse fibre which had been badly cleaned and prepared; many of the fibres were still adhering together in groups in consequence of the gummy matter not having been removed. The strength was poor, and the length of staple varied from 1 foot 9 inches to 3 feet 4 inches.

In the condition of this sample, the fibre would probably be useless for rope-making and would not realise more than about £10 per ton.

The fibre was stated by experts to resemble banana fibre prepared from a tree bearing fruit, and it was suggested that a better fibre would be obtained if it were prepared in the earlier stages of growth.

Sample No. 2, "*Ndehe Ukom*."—This consisted of nearly white, very lustrous fibre. Like No. 1, however, it had not been properly prepared and the fibres were attached together in groups. It was of fair, but uneven, strength and the length of staple was about two feet.

If well prepared this fibre would be quite suitable for rope-

making, but for this purpose the length of the staple should be at least three to four feet. In the state of this sample, it was regarded as worth about £25 per ton, but would be of greater value if the staple were longer.

Sansevieria species.

Sansevieria plants are widely distributed in the tropical regions of both hemispheres. The leaves of many of the species furnish valuable fibres, which are known as "bowstring hemps."

Sansevieria guineensis is found growing in Sierra Leone in a narrow belt along the sea-shore under the shade of trees. It also seems to flourish in places remote from the sea and has been planted recently at Lumley and Mabang. In order to create a profitable industry in the fibre of this species, it would be necessary to employ machinery for its extraction, but at present the plants are not sufficiently abundant in any one locality to warrant the introduction of such machines. Although the Governor of Sierra Leone has afforded facilities for the establishment of somewhat extensive Sansevieria plantations, these do not seem to have been taken advantage of yet to any great extent. It has been suggested that the plant should be grown in the belts, cleared from forest, which the Government has proposed to establish for the protection of cultivated land from forest fires.

A sample of the fibre of *Sansevieria guineensis* from Sierra Leone was examined at the Imperial Institute in 1902 and is described in this *Bulletin* (1903, **1.** 22).

Another sample of this fibre which was forwarded from Sierra Leone in 1905 consisted of nearly white, fairly lustrous fibre, which had been well cleaned and prepared. The fibre was fine, strong, and from 3 ft. 3 in. to 4 ft. 6 in. long.

The results of the chemical examination of this specimen are given in the following table, which also contains those furnished by a sample of *Sansevieria trifasciata* from Assam and by the sample of *Sansevieria guineensis* received from Sierra Leone in 1902.

	Sansevieria species from Sierra Leone.	*Sansevieria trifasciata* from Assam.	*Sansevieria guineensis* from Sierra Leone.
	Per cent.	*Per cent.*	*Per cent.*
Moisture	10·1	9·0	10·6
Ash	0·6	0·6	0·4
α-Hydrolysis (loss)	10·6	10·0	8·9
β-Hydrolysis (loss)	14·1	12·6	13·9
Acid purification (loss)	1·7	2·3	1·8
Cellulose	76·2	74·4	78·0
Length of ultimate fibre	2·1–3·1 mm. or 0·08–0·12 in.	—	1·5–5·0 mm. or 0·06–0·20 in.
Length of staple	3 ft. 3 in. to 4 ft. 6 in.	4 ft. 6 in.	3 ft.–3 ft. 4 in.

These results indicate that this sample is of good quality, and very similar in chemical composition and behaviour to the samples with which it is compared.

The commercial experts reported that the material was of fair colour and of good length and strength. The opinion was expressed that the fibre would be very useful and that if exported in fair quantity it would sell freely at £33 per ton and upwards (March 1906).

In 1906, two samples of the fibre of *Sansevieria guineensis* were forwarded by the Governor of Sierra Leone, one of which had been retted, whilst the other had been prepared without retting. The latter consisted of fine, white, lustrous, well-cleaned fibre of fair strength. The length varied from 1 ft. 10 in. to 3 ft. 9 in., most of the fibre being 3 feet long.

The retted sample had an average length of 3 feet, but some of it was 5 feet long. The fibre was fine but not so lustrous or white as the unretted sample, nor was it so well cleaned and prepared, as there were traces of pulpy tissue and some stains on the fibre. The product was very inferior in strength.

The results of the chemical examination of these fibres are given in table on p. 113.

Of these two samples, the unretted was the better, for although the retted sample was richer in cellulose and less affected on hydrolysis, it was of inferior colour and poor strength. The unretted sample was also better cleaned and stronger than the previous specimens of Sansevieria fibre received from Sierra Leone.

Commercial experts to whom the fibres were submitted expressed the following opinions. The sample prepared without retting was a fine, soft fibre of good colour but rather short in staple. Owing to its shortness the fibre would be unsuitable for rope-making, the required length for this purpose being about 4 feet. Special uses would have to be found for fibre of this character and a nominal value of £40 per ton was quoted for the sample. If of longer staple, it would probably fetch a higher price.

The retted sample was regarded as a rather weak fibre of fair, dull colour and medium length, and was valued at £28–£30 per ton.

	Sansevieria (unretted).	*Sansevieria* (retted).
	Per cent.	*Per cent.*
Moisture	9.7	9·6
Ash	0·7	0·4
α-Hydrolysis (loss)	10·8	9·7
β-Hydrolysis (loss)	13·3	12·5
Acid Purification (loss)	0·8	1·2
Cellulose	78·1	79·5
Length of ultimate fibre	0·8–4·3 mm. or 0·03–0·17 in.	

Two small samples of the fibre of *Sansevieria guineensis* ("Ojakoko") were sent to the Imperial Institute by the Colonial Secretary of Lagos in 1906. These specimens consisted of badly-prepared fibre of very uneven length. It was evident, however, that by careful preparation a fibre could be obtained of useful quality which would probably be saleable at from £20 to £25 per ton.

It was recommended that greater care should be taken in preparing and cleaning the fibre and that efforts should be made to obtain a white fibre of long, uniform staple as in this condition it would realise the highest price.

Dracæna species.

Samples of fibre prepared from the leaves of certain species of *Dracæna* have been received from Sierra Leone and the Gold Coast Colony.

The specimen from Sierra Leone consisted of nearly white, somewhat lustrous fibre which had been well prepared but was of very poor strength. The product was fairly fine and from thirteen to sixteen inches long. It was stated that the plant yielding this fibre occurs in the Protectorate or Hinterland of Freetown as well as in the villages, where it is extensively grown for hedges.

The results of the chemical examination of this fibre are given in the following table and are compared with those furnished by a specimen of the fibre of *Dracæna Draco* from Victoria.

	Sample No 1 from Sierra Leone. *Per cent.*	Fibre of *Dracæna Draco* from Victoria. *Per cent.*
Moisture	10·5	11·2
Ash	0·8	1·7
α-Hydrolysis (loss)	13·8	18·6
β-Hydrolysis (loss)	18.5	22·1
Acid purification (loss)	1·5	—
Cellulose	75·2	69·2
Length of ultimate fibre	1·4–3·6 mm. or 0·06–0·14 in.	1·5–2·5 mm. or 0·06–0·10 in.
Length of staple	13–16 in.	18–22 in.

These figures show that the present sample of fibre is decidedly superior to that of the *Dracæna Draco* in being richer in cellulose and in sustaining a smaller loss in weight when boiled with dilute caustic alkali (α- and β- hydrolysis), and for these reasons it would probably prove more durable. The Sierra Leone fibre is also of better colour than the other specimen, but is somewhat inferior in strength and length of staple.

The commercial experts reported that the fibre was too short for machine spinning and would probably be classed with long tow. The material was stated to be of fair colour, poor quality, rather weak, and of doubtful value, possibly about £12 to £13 per ton (February 1906).

The sample of *Dracæna* fibre from the Gold Coast Colony

was stated to have been prepared in the Botanic Gardens, Aburi, and consisted of clean, well-prepared fibre which was nearly white, fairly lustrous, of moderate strength and from twelve to fifteen inches long.

On chemical examination it gave the following results, for comparison with which the figures furnished by the sample of *Dracæna Draco* fibre from Victoria are added :—

	Fibre of *Dracæna sp.* from the Gold Coast. *Per cent.*	Fibre of *Dracæna Draco* from Victoria. *Per cent.*
Moisture	8·4	11·2
Ash	0·5	1.7
α-Hydrolysis (loss)	16·2	18·6
β-Hydrolysis (loss)	18·5	22·1
Acid purification (loss)	1·7	—
Cellulose	66·5	69·2
Length of ultimate fibre	from 0·4 mm. to 2·6 mm. or 0·016 inch to 0·104 inch (mean 1·4 mm. or 0·056 inch)	1·5 mm. to 2·5 mm. or 0·06 to 0·10 inch

It will be seen from these figures that the present sample of *Dracæna* fibre from the Gold Coast compares very favourably with that of *Dracæna Draco* from Victoria, except that the percentage of cellulose is a little lower.

The small loss sustained by the present specimen on acid purification indicates that it has been well prepared, but on the other hand, the fibre itself is only of fair quality, as the percentage of cellulose is low and the loss on hydrolysis rather high. The latter fact throws doubt upon the ability of the fibre to resist the action of water, and, moreover, the staple is too short to render the material of much value for rope-making.

The fibre was submitted for valuation to experts, who reported that the price of a new fibre of such short staple is uncertain but that material represented by the present sample would probably be worth from £12 to £15 per ton in London. If, however, the fibre could be obtained as stiff as the short Aloe

Fibre from Western India it might be worth from £18 to £20 per ton (May 1906).

On the whole, it would seem scarcely worth while to cultivate this species of *Dracæna* for the sake of its fibre, especially as there are other fibre-yielding plants in the Gold Coast, such as Sansevieria and Hibiscus, which would probably repay attention much better.

MISCELLANEOUS FIBRES.

Raphia vinifera.

Raphia vinifera, the West African "bamboo palm" or "wine palm," is a tree of medium height which abounds in certain parts of West Africa. Accounts of the fibrous products of this palm and their preparation and utilisation have been given in the *Kew Bulletin*, 1891, 1; 1892, 299; 1895, 88, 287. The stems are used for the construction of native dwellings, the leaves are employed for thatching, and from the trunk an intoxicating beverage, known as "bourdon," is obtained. The tree yields fibrous material of two kinds, both of which are of commercial value and are exported.

The first of these consists of strips of the epidermis from the under-surface of the leaves, and is termed "raffia," or "bass." This product is employed in Sierra Leone for twisting up into cords for the manufacture of basket-work, mats and hammocks, and is sometimes dyed with annatto. The exported material is used in Europe chiefly by gardeners for tying up plants.

The other fibrous product obtained from this palm is the "piassava" of commerce, obtained from the fibrous sheaths at the base of the petioles. This material is a stiff, wiry fibre which varies in diameter from $\frac{1}{16}$ to $\frac{1}{30}$ inch, and is used in Europe for the manufacture of brooms and brushes. It is readily obtained in lengths of three to four feet, but cannot be easily procured of greater length without injury to the tree. The fibre is extracted from the stumps of the leaf-stalks by a process of soaking and scraping or beating. There is said to be a large export trade in this fibre from Sherbro, Sierra Leone, but although the palm is common in most of the West African Colonies, the product is not prepared to so large an extent as it well might be.

Cocos nucifera.

The thick, fibrous rind of the cocoanut yields the well-known coir fibre of commerce. During the years 1888–1889, extensive plantations of the cocoanut palm were established in Lagos, and efforts were made, with the aid of the Government, to create an industry in the products. A sample of coir was forwarded to Kew in 1889 for an opinion as to its value, and an interesting account of this inquiry is given in the *Kew Bulletin*, 1889, 129.

During the present year, cocoanut planting has been encouraged in Sierra Leone, and in connection with this development a request was made to the Imperial Institute for information with reference to the preparation and commercial value of the fibre and was accompanied by small samples of the product.

The following notes on this subject may be of interest:—

The fibrous material in its raw state, that is, unbeaten and uncombed, consists of fibres of varying length associated with a quantity of corky tissue. It is necessary to clean and sort the material before shipment, as there is little or no demand for it in the crude state and the freight would exceed the value in this country.

For the preparation of coir fibre the cocoanuts should be gathered before they are quite ripe, usually when ten months old. The fibre becomes coarser as the nuts ripen and then requires to be soaked for a longer period in order to free it from the corky tissue, with the result that the coir acquires a dark colour. In the old, native system of treatment, the cocoanuts are soaked in pits of salt water for several months, but in the preparation of the best commercial coir it is now usual to detach the husks, which is accomplished by striking the nuts on sharp spikes fixed in the ground, and to soak these in large tanks of water warmed by steam. The treatment is much shortened in this way.

After soaking the husks, which facilitates the removal of the corky tissue, they are either beaten by hand or passed through a crushing machine. The fibre, after leaving the crushing machine, is passed into the extractor or breaking-down machine, in which it is completely disintegrated. The product is then

treated by a "willowing" machine to remove the dust and other non-fibrous matter.

After being cleaned, it is of great importance that the fibre should be sorted. It is usually separated by a process of combing or hackling into two grades of different length. The longer or "brush" fibre is employed as bristles for brush-making, whilst the shorter or "mat" fibre is used for the manufacture of mats or ropes. The very short fibres are utilised as a stuffing material in upholstery, and the dust and refuse for gardening purposes.

The commercial value of the longer or "brush" fibre is about £16 to £17 per ton, whilst the shorter or "mat" fibre is worth from £5 to £10 per ton in the London market at the present time. The small specimens of fibre forwarded from Sierra Leone consisted of a mixture of "brush" and "mat" fibre, the former being in the larger proportion.

Elæis guineensis.

The leaflets of the oil palm (*Elæis guineensis*) furnish a fibre of great strength and excellent quality. An account of this fibre and a description of the method by which it is extracted by the natives of West Africa has been given in the *Kew Bulletin*, 1892, 240.

A sample of this fibre prepared in Sierra Leone was forwarded in 1902 to the Imperial Institute for examination, and a report on the quality and value of the product and its chemical composition and behaviour is given in this *Bulletin* (1903, **1**. 21).

Adansonia digitata.

The "Baobab" or "Monkey Bread" tree (*Adansonia digitata*) is extremely abundant in West Africa. The inner bark of this tree is very fibrous and is said to possess properties which render it of exceptional value for paper-making. In order to prepare the fibre, the hard outer bark is first removed by chopping, and the inner bark is then stripped off in large sheets. It is used by the natives for the manufacture of ropes and sacking. A short account of this material has been published in this *Bulletin* (1904, **2**. 169).

An inquiry was received at the Imperial Institute in 1904 from a firm of merchants who desired information as to the possibility of obtaining this fibre, which was desired for a special purpose requiring a large and regular supply. Samples have been received at the Imperial Institute from Sierra Leone and from Lagos which are of the quality demanded, but apparently it is not possible to export the product in large quantities. It has been ascertained recently, however, that the fibre still reaches this country in small quantities and is being used in certain paper-mills.

Fibre and Cloth from Southern Nigeria.

A specimen of the fibrous bark of a plant, which is stated to grow abundantly up the Niger, was forwarded to the Imperial Institute from Southern Nigeria in 1905 together with a sample of cloth woven from the fibre by the natives of Onitsha. The botanical identity of the plant was not known.

The cloth was 40 inches long and 19 inches wide and had a fringe at each end, which had been made by plaiting or knitting the warp material. The warp was found to be composed of the fibre obtained from the bark, whilst the weft consisted of native cotton yarn.

By treating the bark with hot dilute solution of soda a mass of fibres was obtained which varied in length from 0·7 to 1·3 inches and had an average diameter of about 0·00063 inch. The fibre was of fairly regular diameter, and exhibited transverse markings not unlike those present in flax fibre, but in some cases these markings were only faintly developed, and the fibre, therefore, presented a smoother surface. The appearance of the fibre when spun and woven is somewhat similar to that of flax or ramie. Comparative determinations of the strength of a portion of the fibre obtained from the native cloth and that of a standard sample of "middling" American cotton showed that the former was about twice as strong as the latter but was inelastic and brittle.

With regard to the possible commercial application of this fibre, it seems improbable that the material could be produced as cheaply as cotton or flax since, if it were shipped to this country in the same condition as the sample now under consideration,

special processes would have to be devised and machinery constructed to extract and prepare the fibre prior to spinning. The fibre is of approximately the same length as cotton, but, as already pointed out, is less elastic and more brittle, and, moreover, does not possess the peculiar spirally twisted structure to which cotton, as a short fibre, owes its spinning qualities. It is uncertain, therefore, whether the fibre would exert a sufficient grip or binding power to allow of the production of a fine yarn.

FLOSSES OR SILK COTTONS.

Eriodendron anfractuosum.

The seed-hairs or floss of *Eriodendron anfractuosum* is exported in large quantities from Java and is known in commerce as "kapok." An account of the uses to which this product is applied will be found in this *Bulletin* (1905, **3.** 221).

In February 1906 a sample of kapok was forwarded to the Imperial Institute from Lagos with a request for a report on its quality and value. It was explained that the product was discoloured and dusty through having lain on the ground after falling from the trees.

The fibre was darker in colour than ordinary commercial kapok, but otherwise possessed the usual characters, being straight, soft and silky, resilient, and of poor strength. The length of the fibres varied from 0·0012 inch to 0·00033 inch with an average of 0·00075 inch.

The following table includes the results of the chemical examination of the present sample and also of two other samples of kapok for comparison :—

	Present sample from Lagos. *Per cent.*	Genuine Java Kapok. *Per cent.*	Kapok from Seychelles. *Per cent.*
Moisture	9·9	10·9	10·0
Ash	2·8	1·3	2·08
Cellulose	50·3	63·6	61·3

It will be seen from the above figures that the Lagos kapok contains a lower percentage of cellulose and a higher percentage of ash than either of the others.

The sample was valued by brokers at 3½*d.* per lb. in London,

the price of best quality, machine-cleaned Calcutta kapok being $4\frac{1}{8}d.$ per lb. at the same time. The Java and Indian kapoks, which form the bulk of the present supplies, are fairly white, and it might be a little difficult at first to substitute a brown kapok like the Lagos sample. The brokers, however, were of opinion that the product would probably sell freely provided that regular and sufficient supplies could be assured.

This kapok from Lagos is inferior in commercial value to Java and Indian kapok, owing to its darker colour, and to the fact that it is weather-beaten and stained. The fibre would be of better quality if it were collected from the trees without being allowed to fall to the ground. The seeds should be removed before it is exported.

Funtumia elastica.

In 1904, samples of the seed-floss and fruits of *Funtumia elastica*, Stapf, were forwarded to the Imperial Institute from the Gold Coast Colony. It was stated that large quantities of the fibre are available during the months of October and November, and it was desired to ascertain whether the material possesses any commercial value.

The floss was composed of fine silky hairs of a pale, reddish-brown colour and of good length, mostly from $1\frac{1}{2}$ to $2\frac{1}{2}$ inches, but was very weak and lacking in resiliency.

On chemical examination it gave the following results :—

	Per cent.
Moisture	14·7
Ash	3·7
Cellulose	56·4

A representative specimen of the product was submitted to a firm of fibre brokers, who reported that it was of poor quality and not well adapted for use in upholstery or for any other purpose to which the somewhat similar fibre known as "kapok" is applied. The opinion was expressed that the material was not likely to meet with a ready sale in the London market, and was of uncertain value, but, perhaps, might realise $1d.$ per lb., a price which, after deducting the cost of collection and transport, would probably be unremunerative.

This brief account of the many West African plants which yield more or less valuable fibres shows clearly that these materials offer a wide field for development, and that they may prove to be a source of considerable profit to the West African Colonies and Protectorates. Specimens of the fibres and fibrous substances now described can be seen at the Imperial Institute.

TIMBERS FROM THE MABIRA FOREST, UGANDA.

THESE eighteen timbers were collected principally from the Mabira or Chagwe Forest by the Officer in Charge of the Scientific and Forestry Department at Entebbe, and were forwarded by him to the Imperial Institute with a descriptive list of the specimens. Preliminary descriptions of a number of these timbers have been given already in an account of the economic products of the Mabira Forest (this *Bulletin*, 1905, **3**. 41).

The samples were too small for complete investigation and consequently determinations of the mechanical properties of the timbers could not be made, but it has been possible to determine the characters and working qualities of the different woods by practical trials. This work was undertaken for the Imperial Institute by Mr. Herbert Stone, F.L.S., and the results of his examination are included in the following statement, which also gives the descriptions furnished with the samples and the botanical identity of the trees so far as this could be ascertained from the herbarium specimens sent separately to the Royal Gardens, Kew.

The results of the examination may be summarised by stating that although a number of the timbers will be suitable for local use it seems unlikely that any of them could be successfully exported, as they do not possess any distinctive characters or special qualities. A number of the samples were received in a condition unsuitable for examination, being either partially rotten or worm-eaten, but this may be due more to difficulties of collection and transport than to inherent deficiencies of the woods. It is very important, however, that only perfectly

sound samples should be submitted for technical examination, as otherwise a new timber may be unfairly condemned.

"SESAMBYA." Botanical name: *Linociera* (?).

Description.—"A tall straight tree, height 60 to 70 feet, girth 6 to 9 feet, has unbranched bole to a height of 30 to 40 feet; timber white or light brown, very even and close grained, takes good polish, hard and durable; trees plentiful in Mabira or Chagwe Forest."

Characters.—This is an excellent wood, being very solid, straight in the grain, compact and hard. It is inclined to be brittle, but otherwise should make good building timber. It works very well in all sections. The colour, which is pinkish, is not striking enough to be ornamental, so that the wood is not likely to be in demand for export purposes, and it would not fetch a price in Europe sufficient to pay freight, as it would have to complete with St. John's birch and similar low-priced woods. It should, however, be very useful locally providing it be durable. Its hardness equals that of oak and its weight per cubic foot is 63¾ lb. The wood is fissile and does not take nails well. A sapwood tree.

"LUSAMBYA." Botanical name: *Dolichandrone platycalyx.*

Description.—"Tree of dimensions similar to above; timber white or whitish-yellow, very tough and durable, useful and used largely for housebuilding; tree very plentiful in Mabira Forest."

Characters.—This is a light wood which works fairly well with all tools. In colour it is pinkish to brownish and in no way ornamental. It should prove a generally useful wood for purposes where ease of working and lightness are considered. It is of no value for export. Its hardness equals that of English birch and its weight per cubic foot is 42½ lb. The wood cleaves easily without being too fissile to take nails. A sapwood tree.

"MUKOLE." Botanical name: *Dombeya Mukole*, Sprague, sp. nov.

Description.—"Much branched tree, clear bole 15 to 20 feet, girth 6 to 8 feet; timber hard, heartwood walnut colour, good grain, takes good polish."

Characters.—This is a rather dark reddish-brown hard wood of medium weight and poor quality. It works badly, being cross grained and brittle and hence difficult to get smooth. It probably has its uses when employed in large pieces, but it has nothing to recommend it for export. Its hardness equals that of maple and its weight per cubic foot is 48¼ lb. The wood rends raggedly and does not take nails well, as it easily splits. A heartwood tree having sapwood about 2 inches thick.

"NONGO." Botanical name: *Cynometra* (?).

Description.—"Tall straight tree 70 to 80 feet high, clear trunk 40 to 50 feet, girth 8 to 14 feet; wood even grained light yellow; said to be subject to insect attacks."

Characters.—This wood bears a striking resemblance to the Jak-wood of India both in structure and in the peculiar metallic lustre of the surface. If the specimen is a fair sample it is inferior to Jak-wood, as the brown and gold belts are too patchy and spoil the appearance. It is of no export value and the specimen is both unsound and worm eaten, thus throwing a doubt upon the quality of the wood. The sound portions work well with all tools and appear good and firm. It smooths readily and takes nails well. Its hardness equals that of English birch and its weight per cubic foot is 38 lb. The wood rends cleanly and breaks with a long fibrous fracture. The amount of sapwood is not indicated by the specimen.

"MPEWERE OF CHAGWE." Botanical name: *Celtis Soyauxii*, Engl. (?).

Description.—"This is not the Mpiwere of Western Uganda, which is *Piptadenia africana*. Tall tree, similar dimensions to Nongo wood, very light and white in colour."

Characters.—This is an extremely light wood which works easily but is apparently of little durability, as the specimen is tainted throughout and is quite rotten in places. It is of no export value and even locally would serve only for temporary purposes. It takes nails easily, but will not hold them; in fact the wood crumbles as the nail is driven in. Its hardness equals that of Sequoia and its weight per cubic foot is 23 lb. It is presumably a sapwood tree.

"MUGAVU or MUTAMPINDI." Botanical name: *Albizzia Coriaria.* Welw.

Description.—"Wide spreading tree, with short trunk and large branches, wood mahogany colour, extremely hard, heavy and durable."

Characters.—This is a dark brown wood resembling the Lebbek wood of India and might pass for walnut. It is very cross grained, having alternate belts where the fibres run in opposite directions at a considerable angle to each other, hence it is very difficult to get smooth; otherwise it works fairly well with all tools. It absorbs a large amount of polish. The description furnished above compares this wood to mahogany but the specimen does not support this view. Its hardness equals that of maple and its weight per cubic foot is 45½ lb. The wood rends cleanly and takes nails well.

"MUSOGASOGA." Botanical name: *Croton macrostachys,* Hochst.

Description.—"Tree 50 feet high, clear trunk 20 to 25 feet; wood white, very light."

Characters.—The specimen was too much decayed and worm-eaten to test properly. The small portion which remains sound is rather tough. The weight per cubic foot is 34½ lb.

"MUKEBU." Botanical name: *Aleurites* (?).

Description.—"Tall straight tree 50 to 60 feet, trunk 30 to 35 feet; wood brown and mottled, said to be fairly durable."

Characters.—This specimen was also much decayed and no effective tests could be made with it. The weight per cubic foot is 21 lb. The structure of this wood is interesting; the medullary rays are very prominent and the wood possesses a striking silver grain.

"MUVULE." Botanical name: *Chlorophora excelsa,* Benth.

Description.—"Tall straight tree 70 to 80 feet, bole 40 to 50 feet, girth 8 to 18 feet; wood yellowish brown, extremely hard and durable and one of the most useful of Uganda."

Characters.—This is a hard, rather heavy brownish wood, very

cross grained even where the grain is not curly. It is by no means beautiful, though when cut on the quarter (radial section) it shows a pretty mottle with a metallic gloss. It has no export value, but from its solidity it has no doubt many local uses. Its hardness equals that of maple, and its weight per cubic foot is 43¼ lb. The wood rends easily, being very fissile, and for the same reason takes nails badly. A heartwood tree; the sapwood in the present specimen was tainted.

"KASISA." Botanical name: *Celtis kraussianus.*

Description.—"Tall tree 60 to 70 feet, bole 20 to 35 feet, girth 8 to 12 feet; wood whitish, fairly heavy but liable to split."

Characters.—This specimen was also in an advanced state of decay, and was chiefly interesting from the way the fungus had invaded the vessels. No tests could be made in consequence, but the wood is of doubtful value. Its weight per cubic foot is 43½ lb.

"MWOJOLO." Botanical name: *Olacinea* (?).

Description.—"Straight tree about 60 feet high, bole 20 to 35 feet, girth 6 to 10 feet; wood very light in colour, hard, even grained and very useful."

Characters.—This wood is white or very light buff, and has the appearance of being a solid and useful though cross-grained wood. It has no export value. It works easily with all tools but is brittle and difficult to smooth. Its hardness equals that of ash and its weight per cubic foot is 45½ lb. The wood is fissile, rending easily and cleanly; it offers great resistance to nails, which easily split it. A sapwood tree.

"MPIMBYA." Botanical name: *Maba*, near *Maba abyssinica.*

Description.—"Erect tree 70 to 80 feet, bole 30 to 40 feet, girth 6 to 9 feet; wood fairly hard, light in colour with peculiar dark markings."

Characters.—This is a very doubtful specimen with 3 inches of rotten sapwood and an extremely hard, brown heart riddled with worm-galleries. The heartwood is hard to work and brittle. The wood has no export value and unless it has hidden qualities

which outweigh the trouble of working, it will be of little use locally except in large pieces. The peculiar dark markings exhibited by the specimen may be due to the encroachment of the fungus. Its hardness equals that of boxwood and its weight per cubic foot is 61 lb. The wood rends cleanly but not too readily, and offers great resistance to nails.

"BALUEGIRA." Botanical name: *Croton zambesiana Mull. Arg.*

Description.—"Tall tree 70 to 80 feet, trunk 40 to 50 feet, girth 6 to 12 feet; wood light in colour, heartwood brown, fairly hard; when freshly cut has very offensive odour."

Characters.—The specimen has 3 or 4 inches of decayed sapwood and the decay is beginning to attack the heart. This is a hard, cross-grained wood of a dull brown colour streaked with black, not ornamental and of no value for export. It is otherwise a good solid wood, hard to work but useful in large pieces. Its hardness equals that of beech and its weight per cubic foot is 46¾ lb. The wood rends easily and cleanly and offers much resistance to nails.

"MUBAJANGABO." Botanical name: *Zanthoxylon* sp.

Description.—"Tall straight tree, bark studded with brittle corky protuberances which have a thorn at the end. Branches all covered with thorns. Height 50 to 70 feet, trunk 30 to 40 feet, girth 5 to 7 feet; wood very even grained, yellow, hard and durable, useful for panels, etc."

Characters.—This wood much resembles the Cape Silk-bark, having the same silky lustre and pretty speckled silver grain. The specimen shows signs of incipient decay. It is a nice wood to work, being firm, straight grained, solid and yet easily dealt with. It smooths easily and has a natural finish. Its hardness equals that of English birch and its weight per cubic foot is 42 lb. The wood rends straight and cleanly though not too easily; it takes nails well. A sapwood tree.

"MUBAJANGALABI." Botanical name: *Rauwolfia* sp.

Description.—"Tree 50 to 60 feet with boles 20 to 30, girth 6 to 10 feet; wood soft, light, white in colour; bark contains latex."

Characters.—A very light, soft, spongy, light-coloured wood with pinkish streaks. It works very easily, something like American white pine and has a little natural lustre. It seems subject to rapid decay as the specimen is slightly tainted. It is of no export value and will serve temporary purposes only. Its hardness equals that of white pine or Sequoia. The weight per cubic foot could not be determined owing to the condition of the specimen. The wood is fissile, rends very easily and straight, takes nails well but does not hold them very tenaciously.

"JOGE." Botanical name: *Albizzia* sp.

Description.—"Erect tree 70 to 90 feet, bole 30 to 40 feet, girth 6 to 10 feet; wood dark, hard, heavy and durable."

Characters.—A leguminous wood scarcely distinguishable from "Mugavu" (see above). It has rather more natural lustre, but otherwise all the remarks made regarding Mugavu apply in this case also. The weight per cubic foot is 41¾ lb.

"OMUVUMU." Botanical name undetermined.

Description.—"Tree 60 to 70 feet high, girth 6 to 12 feet; wood dark, heavy and durable."

Characters.—A very heavy, very hard, cross-grained brown wood of great solidity, difficult to work and troublesome to smooth. It has no export value but would no doubt be valuable locally for purposes where large pieces are needed. There appears to be no sharp distinction between the wide greyish sapwood and the rather agreeably coloured heartwood. Its hardness equals that of boxwood and its weight per cubic foot is 20½ lb. The wood is very fissile and easily split by nails; it rends badly in a spiral direction like the wood of some eucalypts.

"OMUKUSU." Botanical name undetermined.

Description.—"Tall tree, with large roots branching from the trunk often 10 feet above ground; wood light in colour, fairly hard and heavy and very useful."

Characters.—This is the prettiest wood of the series, being of a pleasant reddish colour and having a very pretty silver grain and lustrous surface when quartered. It works easily and fairly well

with all tools but is a little rough to finish. It would serve similar purposes to those to which American birch of medium quality is applied and should be an equally useful wood. It is doubtful if it would compete unless cheaper. Its hardness equals that of American birch and its weight per cubic foot is $37\frac{1}{2}$ lb. The wood is fissile, rends easily and straight and takes nails well.

THE OCCURRENCE OF INDIGO IN THE "GARA PLANT" OF SIERRA LEONE.

A SUPPLY of the leaves and twigs of the "Gara plant" (*Lonchocarpus cyanescens*) was received recently at the Imperial Institute, together with samples of the same material made into balls for use by native dyers and specimens of the roots of *Morinda citrifolia*, which is employed by the natives in association with "Gara" in dyeing.

The gara plant appears to be used commonly in West Africa as a blue dye, and for this purpose the young leaves are collected and whilst still fresh are pounded and made into balls about 4 inches in diameter, in which condition the dye stuff is stored until it is required or the leaves may be simply broken up and allowed to dry in the sun.

In dyeing with this plant the prepared gara is soaked in water for about 12 hours and the yellowish liquid so produced is decanted and thrown away, the wet residue being allowed to ferment for two or three days. During this period of fermentation powdered root bark of the "brimstone" tree (*Morinda citrifolia*, is added together with some potash. Water is eventually added to the mixture together with a decoction of the morinda bark and more potash. At this stage the mixture is left exposed to the sun all day and stirred from time to time, but is covered up at night. After about nine days the dye bath is ready for use, and the fabric to be treated is thrown in, moved about in the liquid, left there for some time and then dried in the sun. This operation is repeated until the required shade of blue is obtained.

The material forwarded to the Imperial Institute was submitted

to Mr. A. G. Perkin, F.R.S. of Leeds University, who kindly undertook to investigate the colouring matter yielded by the dye stuff, and the results obtained are given in a paper read at a recent meeting of the Society of Chemical Industry (*Journ. Soc. Chem. Ind.* 1907, 267). It was found that the blue dye obtainable from the Gara plant is indigo identical with the dye obtained from various species of *Indigofera*. It is well known that indigo does not occur, as such, in the plants from which it is usually prepared, but is produced by the decomposition of a glucoside, indican; one of the products of this action, known as indoxyl, being subsequently converted by the oxygen of the air into indigo; and it is probable that the fermentation process which precedes the preparation of the gara dye bath effects the production of indigo from a glucoside of the indican type occurring initially in the plant. The preparation of the dye bath, involving the addition of a decoction of morinda bark and of potash, probably effects the solution of the indigo formed in the fermentation process, and so brings it into the condition in which it can be used as a dye. It is interesting in this connection to note that the composition of the gara dye bath as used in Sierra Leone is very similar to that of the "potash indigo vat" which is used by the Hindoos in dyeing with indigo.

It is at present impossible to say whether the gara plant can be employed as a source of indigo for export, but a supply of unfermented leaves has been asked for from Sierra Leone so that this point can be fully investigated.

TOBACCO FROM NORTHERN NIGERIA.

THIS sample of native-grown tobacco was forwarded to the Imperial Institute for chemical examination and commercial valuation by the Forestry Officer for Northern Nigeria.

The sample weighed about 8 oz. and consisted of about 100 leaves varying from 6 to 8 inches in length and from 2 to 4 inches in width. The leaves were rolled up and a good deal broken; they had a fairly uniform light-brown colour,

though a few showed spots and traces of mildew. The tobacco had a pleasant though somewhat faint aroma and burned well when ignited.

No information was supplied with the sample as to the species of *Nicotiana* from which this tobacco is derived, but it was stated that "it was grown on the banks of the Kaduna river and simply sun-dried." It appears, however, that the leaves have undergone some fermentation.

Chemical Examination.

A representative sample of the tobacco was analysed in the Scientific and Technical Department of the Imperial Institute and gave the following results:—

	Per cent. (calculated on material dried at 105° C.)
Moisture	12·8
Ash (pure)	13·1
Sand	3·6
Reducing sugar	2·9
Acidity	2·7 *grams of potash required to neutralise* 100 *grams of tobacco.*
Nicotine	2·65

These results show that this tobacco contains more sand than is usual. This is probably due to careless collection. Further the quantities of "sugar" and "acid" present are unusually high, probably as the result of insufficient fermentation. The quantity of nicotine present is satisfactorily small and is about normal for light tobacco.

Commercial Valuation.

The sample was not in good condition for commercial valuation, but as the results of the chemical examination were promising it was considered desirable to submit a specimen of the tobacco to a firm of manufacturing tobacconists, who were informed of the result of the chemical examination. They reported that "the tobacco appears to be ripe and well fermented; but is too dark for cigar requirements. The leaves

are too thick and the texture too heavy to be advantageously used for wrapping cigars. As regards the flavour, it is too pungent to be used alone for filling cigars, but when mixed with other milder cigar fillers, in proportion of about 30 per cent., it blends satisfactorily. So far as concerns burning qualities we are glad to be able to give an entirely satisfactory report, as the leaf comes out well in all respects. In its present condition we should value the tobacco at about 4*d.* per lb. for cigar purposes, or it might be used for manufacturing purposes, in which case we should expect to be able to buy it at rather less than 4*d.* per lb."

These results are satisfactory when it is considered that this tobacco is grown by natives for local use and without any special precautions being taken to produce tobacco for European markets. The price quoted, viz. 4*d.* per lb., although about the lowest price paid for tobacco in the British markets, is the same as that obtained for much of the American manufacturing tobacco which reaches this country, and it is possible that even in its present condition this tobacco would pay to export from Northern Nigeria. The results are so promising, however, that it would be worth while to consider the question of improving the tobacco produced in the country. For this purpose it would probably be necessary to engage one or more experts to instruct the natives in the cultivation of the plant, the "curing" and fermentation of the leaves after collection, and the methods of preparing and packing the tobacco for export to this country.

"IKPAN" SEEDS FROM SOUTHERN NIGERIA.

A SAMPLE of "Ikpan" seeds was received at the Imperial Institute from Messrs. Alexander Miller Brother and Co. It was stated that they are very abundant in the Cross River district of Southern Nigeria, where they are cultivated and used for food by the natives.

The seeds could not be identified at Kew, but it was stated

that they are probably derived from a plant belonging to the natural order Cucurbitaceæ.

The seeds were extracted with light petroleum and yielded from 40 to 41 per cent. of a pale yellow oil, which in cold weather deposits a small amount of solid matter, which does not again pass into solution at ordinary temperatures. On chemical examination the oil proved to be very similar to cotton seed oil in composition and properties, as the following constants show:—

Specific gravity at 15° C. .	0·9184	
Acid value . . .	5·5	*milligrams of potassium hydroxide required per gram of oil.*
Saponification value . .	194·0	
Iodine value . . .	106·0 *per cent.*	
Hehner value . . .	95·5 *per cent.*	
Titer test	36·0° C.	

In preparing the sample of ikpan seed oil for analysis, the last traces of the extracting solvent employed were removed from the oil by the method usually adopted in the Department, viz. heating the oil *in vacuo* at 100° until the weight becomes constant.

Samples of the seeds and oil were forwarded to a commercial firm, who reported that the oil could be used for the same technical purposes as cotton seed oil, and that its value for soap-making would probably be £1 per ton less than that of cotton seed oil. It was further stated, however, that the taste of the oil and its behaviour under the influence of heat indicate that it should be specially suitable for dietetic use, and it was thought that the oil from these "Ikpan" seeds might prove equal for edible purposes to the best Arachis nut oil, which varies in value from £30 per ton. In order to form a definite opinion upon this point at least one ton of the seeds would be necessary to enable the suitability of the oil for edible use to be properly determined.

The cake left after the expression of the oil from the seeds would probably prove to be a valuable cattle food. It is very rich in albuminoids and would, on that account, be suitable for mixing with feeding materials poor in proteids in order to raise the proportion of albuminoids to the required amount. Like all

new cattle foods, however, it would require to be tested by feeding trials before being recommended for general use.

Information as to the botanical origin of this seed has been asked for.

SEEDS OF *ALEURITES FORDII* AND *ALEURITES TRILOBA* FROM HONG KONG.

Aleurites Fordii.

A SAMPLE of the seeds of a species of Aleurites, which has since been identified at Kew as *Aleurites Fordii*, Hemsl., was forwarded for examination to the Imperial Institute by the Superintendent of the Botanical and Forestry Department, Hong Kong.

It was stated that this species of Aleurites is one of the trees grown in China for the production of Chinese wood-oil (T'ung oil), and that it occurs in Fokien Province intermixed with *Aleurites cordata*, which was formerly considered to be the sole source of wood-oil. It was thought, therefore, that it would be of interest to have an examination made of the oil from the seeds of the new species, in order to determine its quality in comparison with that of the T'ung oil of commerce, which appears to be prepared indiscriminately from the seeds of *Aleurites cordata* or *Aleurites Fordii*, or mixtures of the two.

Description of Sample.—The sample consisted of two bags of nuts weighing 500 grams. The kernels of the nuts were fresh and in good condition on arrival.

Examination of the Oil.—On extraction with light petroleum, the kernels were found to contain 58·3 per cent. of oil, which is equivalent to a yield of 36·4 per cent. from the entire nuts.

The oil was light in colour, and, on exposure to air in a thin layer, dried in a day at the ordinary temperature, giving a varnish-like residue. On heating in a water-oven at 100° C. the oil dried and formed a resin-like solid.

The "constants" of the oil were determined and found to

agree well with those recorded for commercial samples of T'ung oil, as shown by the following table :—

	Oil from seeds of *Aleurites Fordii.*	Commercial T'ung oil.	
Specific gravity at 15° C.	0·9404	0·9360	
Acid value . . .	2·89	—	Milligrams of potassium hydroxide required per gram of oil
Saponification value	191·8	155–211	
Iodine value . . .	166·7	149–165·7 *per cent.*	
Hehner value . .	94·6	96·0–96·6 ,, ,,	
Titer test	42–42·5° C.	37·1–37·2° C.	

The examination has shown that the oil extracted from these seeds of *Aleurites Fordii* is similar in composition to the T'ung oil of commerce. It is, however, lighter in colour, and produces a lighter-coloured varnish on drying, so that it is probably a purer product. It is noteworthy also that it has a higher titer test than commercial T'ung oil.

It was impossible, with the small amount of material available, to determine whether the oil of *Aleurites Fordii*, if prepared on a large scale by a commercial process, would be superior in quality and value to the mixed wood-oil of commerce derived from the two species. Technical trials would be necessary in order to determine this point, and for such trials about two gallons of the oil, or one hundredweight of the seeds would be required.

Aleurites triloba.

This sample of the seeds of *Aleurites triloba* was also forwarded for examination to the Imperial Institute by the Superintendent of the Botanical and Forestry Department, who stated that *Aleurites triloba* is one of the best shade trees in Hong Kong, where it grows very quickly.

The seeds of this tree, which is frequently referred to in technical literature as *Aleurites moluccana* (given as a synonym for *A. triloba* in the Index Kewensis), are commercially known as "candle nuts," and the kernels are already exported from Fiji, New Zealand and Australia. The oil which they contain is used for soap-making and other purposes, both in this country and on the Continent.

Description of Sample.—The sample consisted of four pounds

of the seeds, the kernels of which were nearly white, and free from discolouration.

Examination of the Oil.—The oil was extracted by means of light petroleum, and the kernels were found to contain 60·8 per cent. of oil, which is equivalent to a yield of 19·8 per cent. from the unshelled seeds. The oil dried on exposure to air in thin films in about ten days.

A number of analyses of candle-nut oil have been made previously, and these show considerable variation in the principal constants recorded. The results obtained at the Imperial Institute by the analysis of oil extracted from the present sample of seeds, and those obtained by investigators who have examined candle-nut oil previously, are given in the following table:—

	Oil from *Aleurites triloba*, examined at the Imperial Institute.	Oil from *Aleurites moluccana*. Examined by Lewkowitsch.	De Negre.	Fendler.
Specific gravity	0·9274 (15° C.)	0·92565 (15·5° C.)	0·920 (15°)	0·9254
Acid value	1·72	—	—	—
Saponification value	204·2	192·62	184–187·4	194·8
Iodine value	139·7	163·7	136–139	114·2
Hehner value	96·4	95·5	—	—
Wollny-Reichert value	1·98	—	—	—
Titer test	17·8° C.	—	20°–21° C.	18°

These results indicate that the oil belongs to the class of drying oils typified by linseed oil, and would be suitable for the manufacture of soft soap and in the preparation of oil-varnishes, paints and linoleum and other similar purposes, to which oils of this class are applied industrially.

Samples of the nuts were submitted to brokers, who stated that the *kernels* would meet with a ready sale at £12 to £13 per ton, but pointed out that the unshelled nuts could not be disposed of in this country.

CHROMITE AND OTHER MINERALS FROM RHODESIA.

CHROMITE.

THIS sample of chromium ore from Southern Rhodesia was sent to the Imperial Institute by the British South African Company for chemical examination and commercial valuation.

It weighed about two pounds, and consisted of a mixture of chromite and picotite in granular crystals, which were surrounded with a thin coating of serpentine.

Results of Examination.

On analysis the ore gave the following results :—

		Per cent.
Chromium oxide	Cr_2O_3	46·36
Alumina	Al_2O_3	13·18
Ferrous and ferric oxides (calculated as FeO)	—	18·66
Cobalt and nickel oxides	$\left.\begin{matrix} NiO \\ CoO \end{matrix}\right\}$	0·17
Magnesia	MgO	13·64
Silica	SiO_2	4·58
Water	—	2·72

A dry assay of the sample showed that the mineral contained a trace of platinum.

The amount of chromium sesquioxide present in the sample is about the same as that contained in the second-grade chromium ores of commerce. The percentage of silica is rather high, owing to the presence of serpentine, which occurs in films between the chromite granules.

It would be desirable to concentrate this ore before export, but, owing to its condition, this would be rather difficult, though possibly some improvement might be effected by crushing and washing.

Crude chromium ore is sold in the United Kingdom and the United States on a basis of 50 per cent. of chromium sesquioxide. The average price paid for such 50 per cent. ore during 1905 was £3 10*s.* 0*d.* per ton, with an addition of from 1*s.* 8*d.* to 2*s.* 0*d.* per ton for each unit per cent. of sesquioxide above 50 per cent. The present value of such ores in London is £2 17*s.* 6*d.* per ton, with an additional 2*s.* 6*d.* for each unit of sesquioxide above 50 per cent.

Ores containing less than 50 per cent. of sesquioxide are saleable at correspondingly lower prices. At present, second-grade ores containing at least 40 per cent. of chromium sesqui-

oxide are worth £2 per ton in London, with an additional 1*s.* 9*d.* for each unit per cent. in excess of 40 per cent. The Rhodesian ore would therefore be worth about £2 11*s.* 6*d.* per ton in London at the present time.

The ore contains a small amount of cobalt and nickel, but the quantity of these metals present in the sample is too small to be of commercial importance. The possibility of the occurrence of ore richer in cobalt and nickel, and of value as a source of these metals, should however be borne in mind.

The fact that the mineral contained a trace of platinum, though of no practical importance in this connection, should not be overlooked in its relation to the possible occurrence of this metal in larger quantities in other parts of the same country. It has been already shown by investigation at the Imperial Institute that platinum occurs in British Central Africa. (See this *Bulletin*, 1905, **3**. 135.)

ANTIMONY ORE.

The sample of antimony ore was received from the British South Africa Company with the request that it might be examined, and an opinion obtained as to the value of similar ore delivered in London in lots of from 5 to 10 tons. It was stated that the ore is believed to contain gold.

Description of Sample.

The sample, which weighed two pounds, consisted of pieces of massive stibnite (antimony sulphide) with one piece of quartzose ore. A superficial coating of iron pyrites was observed on one piece.

Results of Examination.

A representative sample of the ore was analysed, and gave the following results:—

	Per cent.
*Antimony Sb	65·67
Ferric oxide Fe_2O_3	0·30
Residue insoluble in acids (chiefly quartz)	7·95

* *Equivalent to* 91·85 *per cent. of stibnite* Sb_2S_3.

The ore was assayed for gold and silver, but these metals proved to be absent.

The results of the analysis show that the ore is of good quality. It consists essentially of stibnite (sulphide of antimony), associated with quartz and containing small quantities of other minerals. It could be readily cleaned from the quartz by hand-picking.

Commercial Valuation.

In November 1906, when this ore was received and examined, it was valued at £31 2*s.* 6*d.* per ton. Since then the price of antimony ore has fallen, and this Rhodesian ore is probably worth about £18 per ton at current rates.

VARIOUS MINERALS.

The following samples of quartz and pyrites were received from Northern Rhodesia through the British South Africa Company.

Ref. No. RdC_2.—Described as "rock reported to contain gold."

The locality from which the sample was obtained was not stated. This material was a dolerite composed of the two minerals hornblende and felspar. It was assayed for gold and this metal proved to be absent.

Ref. No. RdC_{3-7}.—Described as "from a reef 15 miles from Mliro, N.E. Rhodesia."

This sample consisted of three pieces of quartz porphyry and one piece of ferruginous felspathic sandstone. The quartz porphyry was assayed for gold and proved not to contain this metal. The sample of sandstone may possibly contain gold, but it was too small for purposes of assay.

Ref. No. RdC_8.—Described as "from a hill about 20 miles from Mliro, N.E. Rhodesia."

This sample consisted of vein quartz. It was assayed for gold, but proved not to contain this metal.

Ref. No. RdC_{11}.—Described as "iron pyrites from the Sasare Mine, N.E. Rhodesia."

This was a sample of massive iron pyrites. A representative portion was assayed and found to yield 1·61 ounces of gold per ton of 2,240 lb. The amount of sulphur in the sample was 49·46 per cent., which is only a little below that present in pure iron pyrites, viz. 53·4 per cent.

GENERAL NOTICES RESPECTING ECONOMIC PRODUCTS AND THEIR DEVELOPMENT.

INSECT AND OTHER COTTON PESTS, AND THE METHODS SUGGESTED FOR THEIR DESTRUCTION.

USEFUL accounts of the insect pests affecting the cotton plant have been issued by the Bureau of Entomology, United States Department of Agriculture, Washington, and the Imperial Department of Agriculture of India (Research Institute). These records of cotton pests, however, are not entirely applicable to some of the British Possessions in which cotton growing has been recently developed, although they comprise many species which are very widely distributed and must therefore be included among the possible devastators of cotton in all parts of the British Empire. In addition to the above-mentioned reports, there are notices which have been published from time to time in India relating to the cotton pests of that country. These have chiefly appeared in the *Indian Museum Notes* of the last fifteen years. The Khedivial Agricultural Society at Cairo have in hand a treatise on the cotton pests of Egypt, the first part of which has been published in the Year-Book of the Society for 1905. The *West Indian Bulletin* of the Imperial Department of Agriculture also has papers upon economic entomology which contain much matter relating to cotton pests.

The following account, prepared by Mr. Gerald C. Dudgeon, Superintendent of Agriculture for British West African Colonies and Protectorates, is based upon the above-mentioned papers and supplemented by notes taken from his own reports upon

cotton in the United States, Egypt, the Sudan and the West African Colonies.

Excluding the "Mexican Boll weevil" (*Anthonomus grandis*) which is at present confined to the more Southern States of North America and Mexico, the largest share of damage done to cotton may be attributed to Lepidopterous insects. For this reason, the most important of these will be considered first.

I.—LEPIDOPTEROUS INSECTS WHICH ATTACK THE FLOWER-BUDS AND BOLLS.

1. "The American Cotton Boll-Worm" (*Chloridea obsoleta*, Fabr., syn. *Heliothis armigera*, Hübnr.).

This insect has been found in North, Central and South America; Upper Egypt, Northern Nigeria, and south to Cape Colony; Asia, from Arabia to Japan, excluding Siberia; Australia, New Zealand and Pacific Islands; and Southern and Central Europe. It is therefore impossible to grow cotton anywhere where its freedom from the attacks of this pest could be assured, and owing to the way in which large tracts of cotton plantations have been devastated by its ravages, it has become recognised as one of the most serious enemies of the cotton plant.

The following is a brief account of its life-history:—

The *eggs* are laid upon the leaves and stalks of various plants, but especially on the silky tufts which protrude from Indian corn (maize) ears. On these they are easily distinguishable without a lens, and appear to the naked eye to be oval in shape and of a whitish or yellowish colour. Unlike the eggs of many other moths they are deposited singly and often at a considerable distance from one another. They hatch out according to temperature, in from 2½ to 6 days, and the young *caterpillars* at once feed upon the softer portions of the plant. In this stage they are so minute that they are scarcely noticeable, but, when the weather is favourable, they develop at a great rate, and upon cotton plants may be found attacking flower-buds and green bolls on the second or third day. They show a remarkable diversity in colouring as they grow larger; some being greenish and without markings, while others vary from pinkish brown to dark brown with longitudinal stripes of darker colour along the

back and sides, which stripes are often finely outlined with white; there are also distinct spots upon some of the segments. Growth is normally completed in from twelve to fifteen days, and the full-grown caterpillar often reaches 1½ inches in length. The *chrysalis* or *pupa* is formed in a mud cell generally not more than an inch or two below the surface of the ground, and the moth emerges in the warm months after about twelve to fifteen days, although in temperate countries those caterpillars pupating in the late autumn do not turn to moths before the following spring, thus remaining underground in the pupa state for the whole winter. The colour of the pupa is a light mahogany brown, and, just previous to the moth's emergence, it becomes darker. The moths (excluding those developed from hibernated pupæ) are produced in from 30 to 40 days from the time of the eggs being laid. In this manner it is usual to find from five to seven generations occurring during one cotton season. It will be realised from this, and from the fact that each generation becomes larger than the last, how very necessary it is to check it at the earliest possible moment. The *moth* has the forewings generally dull ochre yellow to olive green, or reddish-brown with three or four waved darker lines crossing them, the space between the two outer waved lines often being of a darker colour or having a row of white specks on the veins. The hindwings are whitish with the veins brown and a dark clouded mark over the outer third of the wings; this clouded patch has usually pale spots on it. The moth is an active day as well as night flier, and may often be seen hovering over flowers, chiefly about sunset, or depositing its eggs while wandering about with a curious trembling motion of the wings.

The presence of the caterpillars is made known by holes bored into the flower-buds or cotton bolls with an accumulation of excreta attached to the outside. Often and especially when the caterpillar is full grown, half the body is seen on the outside of a boll and the fore part is inside where the animal is feeding.

Remedial measures. This caterpillar being almost omnivorous, is difficult to exterminate, but the crops which it chiefly affects in the United States are maize, cotton, and tomatoes. Almost any plant with a fleshy bud or with a large seeding

head may be attacked, and, in addition to those named above, peas and beans of different species as well as sunflowers (*Helianthus*), Tobacco (*Nicotiana*), Pelargonium, Roses, Reseda, and Calamintha may be mentioned. Owing to the preference that the moth seems to exhibit for laying its eggs upon the silk tufts of maize and the protective covering afforded to the caterpillar while feeding in the maize ear, the insects are more common upon this crop than upon cotton. This has suggested the plantation of what are called trap crops of maize between the rows of cotton. It is usual to plant these at three different times in the cotton season in order to destroy three consecutive broods of the worm. The following system of planting maize trap crops has been very successful. Five rows are left vacant between every 25 rows of cotton, one of which, as soon as possible, is planted with early maturing sweet maize. When the ear silk appears, careful examination is made for the eggs of the moth, and, when no more fresh eggs are apparent, the whole plant is cut down and burned or fed to cattle. Three more rows of maize are then planted so that the silking time of the ears comes on about the 1st of July. Upon these ears a large number of eggs will be found, and, in this case, they should be allowed to mature in order to prevent the destruction of the natural enemies, which are parasitic on the eggs and the larvæ (caterpillars). The crowded condition of the worms on these ears induces cannibalism to such an extent that few reach maturity. No destruction of this corn is recommended until the whole generation has been parasitised, or at most the very small remainder have developed. The fifth and last row of maize is then planted to catch the eggs of the remaining few, and these are destroyed by burning the ear silk, as soon as laying has apparently ceased. During the early stages of the boll-worm it may be poisoned by applications of Paris green to the plants, but owing to its habit of getting inside the boll, it is less easily destroyed in this way later. Ploughing the ground in order to kill the pupæ is also resorted to, and often has beneficial effects. The use of lights, however, for the attraction of the moths, or of poisoned syrups for the same purpose is not recommended, as, by this means, other insects are destroyed which may be harmless to the crops or even inimical to the boll-worm.

Owing to the recent discovery of the American boll-worm in Upper Egypt some method for its destruction there may soon become necessary, and, as the usual arsenical poisons might be less used there for the destruction of cotton pests than for that of human life, it is not recommended that they should be introduced. The same applies to all countries where the natives have not become sufficiently educated to regard poisoning as a serious offence. Arsenical poisons for this reason should not be applied to cotton in West Africa, but it does not seem probable that the American boll-worm will develop into a troublesome pest there. The conditions which the American boll-worm has to face in West Africa are different from those found in the United States or Egypt, where a great fall in the temperature is experienced in the winter months, which causes the pupæ to be checked in development and to remain underground during the whole period when the food plant is non-existent. In West Africa, where cotton is being grown, the winter months have as high a temperature as the summer months, but there is a deficiency of food owing to the absence of moisture. During these long periods of dry hot weather the generations of the boll-worm are continued, but there is such a scarcity of food that the few individuals that survive to become moths are weak and dwarfed. For this reason there is little danger that the boll-worm will ever become a serious pest in West Africa.

There are several well-known parasites upon the caterpillar which must be looked upon as of the utmost assistance to the farmer, and therefore should not be destroyed. It has been ascertained that small Hymenopterous insects belonging to the family *Chalcididæ* infest the inside of the eggs, and that, during certain periods, they destroy from 50 to 75 per cent. of them. The chief American egg and larva infesting species are *Chalcisovata*, *Trichogramma pretiosa*, *Euplectrus comstockii*, and a *Limneria sp.* Wasps and ants carry away the caterpillars for food, a two-winged fly (*Tachina*) destroys a number, and the Hymenopterous insects of the family *Ichneumonidæ* deposit their eggs upon the skin, through which the grubs perforate when hatched out, and feed upon the intestines of the caterpillar. In the United States the caterpillars are subject to a

bacterial disease which destroys many in spring and autumn. Woodpeckers and other birds extract the worms from the maize ears.

In spite of this formidable array of natural enemies and the operations conducted against the insect by means of insecticides and trap crops, the American boll-worm must still be considered one of the most harmful pests known.

2. "The Egyptian Cotton Boll-Worm" (*Earias insulana*, Boisd.). This insect has been observed in East, Central and South Africa, Egypt, Northern Nigeria, India, Burma, and Siam.

It may be looked upon as a cotton pest of a very destructive nature, and possibly occurs throughout the whole of the cotton regions of Africa. Its effects are the same as those of the American boll-worm, but owing to its smaller size, it can completely enter flower-buds and small bolls, and is, therefore, less liable to attack from birds or parasitic insects. It has caused vast damage to the cotton crops in Egypt and Northern India, and larvæ and pupæ of an *Earias*, almost certainly this species, have recently been sent from the Resident of Bornu, Northern Nigeria, to the Political Assistant of that country, whence they were forwarded through the Conservator of Forests, for identification. Mr. Dudgeon compared these with his Egyptian specimens and found no difference in their structure or general appearance. There is no evidence that the Egyptian boll-worm has reached the Sudan.

An account of the life-history of this insect and the measures recommended for its suppression has already been given in this *Bulletin* (1906, **4**. 48).

3. *Earias fabia*. Another species, *Earias fabia*, Stoll, has been found in Egypt and Western India feeding upon cotton, although it is best known, in India at least, as a pest attacking the edible pod of *Hibiscus esculentus*. It differs in no way from *Earias insulana* in habits, but is slightly larger. The markings on the wings of the moth are very distinct; the borders of the forewing are broadly white in front and behind, and there are no transverse lines. It has been observed in India, Ceylon, Java and Egypt.

Other Lepidopterous insects which have been recorded as

occasionally destructive to cotton bolls are two closely allied moths of the sub-family *Acontiinæ*, namely, *Acontia malvæ*, Esper., and *Tarache catena*, Sowerby, and two also closely allied butterflies of the family *Lycænidæ*, known as *Uranotes melinus*, Hübnr., and *Calycopis cecrops*, Fabr.

4. *Gelechia gossypiella.* Mr. Maxwell Lefroy records the larva of a very small brown moth, identified as *Gelechia gossypiella*, Saund., which he calls the "pink boll-worm" on account of the larva being pink when full grown. These larvæ were found damaging cotton bolls in several parts of India.

5. *Acontia malvæ.* This occurs in Europe and throughout the Indian region as far as Formosa. The *caterpillar* in Europe is green and marked with yellowish spots. The young caterpillars of this and the next species can be easily distinguished from those of the American boll-worm by their possession of only four, instead of five, pairs of abdominal legs. The *moth* is a canary yellow insect with a white hindwing. The forewing has some waved brown transverse lines and a triangular patch upon the outer edge of it. It is a common insect, but only occasionally attacks cotton.

6. *Tarache catena*, Sowerby Wlk., recorded from Bombay, Punjab and Bengal. This insect was also mentioned by Mr. Maxwell Lefroy as occasionally feeding on the cotton plant, but can hardly be regarded as of more than accidental occurrence. The *moth* is white with leaden-coloured spots and a broad band on the outer edge of the forewing. The hindwing has a broad dusky border. The *caterpillar* is green.

7. *Uranotes melinus*, Hübnr., is found in the Southern States of North America, where it is sometimes referred to as "the cotton square borer" from its habit of boring into the flower-square or bud. The *butterfly* is purplish brown with reddish border spots on the hindwings and a pair of finely developed tails. The *caterpillar* is green, oval, and slightly flattened in form, and covered with short hair. The head is usually kept retracted under the front of the body. The pupa is brownish or green and is attached by a fine cord to the stem of the plant. The eggs are laid upon the leaves and stems. This pest is recorded as being commonly found on hops, beans and cowpeas, but is said to show a preference for cotton. Fortunately, the

caterpillars are very largely parasitised by a Dipterous as well as by a Hymenopterous insect. In Texas it was found that in the mid-summer brood over 90 per cent. were destroyed. For this reason it is scarcely worth while to interfere with it, although if remedial treatment be found necessary, Paris green dusted over the foliage, when the caterpillars are small and before they have entered the squares, is recommended.

8. *Calycopis cecrops*, Fabr., is also found in the Southern States of North America. The butterfly is blackish with pale blue patches on the hindwings and on the hind parts of the forewings. It has two pairs of slender tails to the hindwings. The damage done by it is similar to that done by the last species and it has occasionally been reported as having caused the loss of a considerable amount of cotton in Texas. This insect is also largely parasitised and is therefore unlikely to spread.

II.—LEPIDOPTEROUS INSECTS WHICH INJURE THE FLOWERS.

9. "The American Cotton Worm" (*Alabama argillacea*, Hübnr.) has been observed in the United States, Mexico, West Indies and Central America. The eggs are bluish-green and rather flattened, and bear a number of radiating ridges. They are usually found singly upon the underside of the leaves, but often several may be found on one leaf. The *larva* hatches out in three or four days, though in the colder weather it may take longer. The young larva feeds at first upon the underside of the leaf, eating only the lower parenchyma. In a very short time it assumes larger proportions and devours the whole leaf, occasionally even eating the branches and damaging the bolls, especially when the leaves become scarce. It is at first pale yellow, gradually becoming greenish and marked with a dark band down the back with seven longitudinal pale yellow lines and numerous yellow-ringed black dots on each segment. The caterpillar stage lasts from one to three weeks. It is very active and, owing to the absence of the first pair of abdominal legs, walks with a kind of "looping" action. When disturbed it throws itself off the leaf or stem and remains suspended by a thread. The *pupa* is formed in a thin silken cocoon, generally

enclosed in a rolled leaf; it is brown and shiny. It remains in this condition from one week to a month. The *moth* is dull reddish-brown to olive-grey with a dot in the middle of the forewing and three cross-lines. It flies by night and is attracted to ripe fruit or flowers. The female lays from 300 to 600 eggs and there are usually five broods during the American cotton season. It has been ascertained that the moths hibernate in the southern portion of the American cotton belt and each season travel northward, sometimes occurring in numbers as far north as Canada. The caterpillar destroys melon and peach crops in some parts of the United States. It is fortunate that the number of parasitic insects which infest the larvæ and eggs is extensive; the egg parasite, *Trichogramma pretiosa*, sometimes almost entirely annihilates a whole brood, while *Calchis flavipes*, *Euplectrus comstockii* and *Pimpla conquisitor* account for the destruction of large numbers of caterpillars.

In order to destroy this pest several machines have been devised for the underspraying of cotton plants with liquid poisons, but none have proved successful in practice. The best results are obtained by dusting the plants with Paris green. A pole carrying a bag of powder at each end is placed across the back of a horse or mule which is ridden down alternate lines, and in this way two rows of cotton are dusted simultaneously. In Texas, where the cotton worm is extremely plentiful, only the earlier broods of it are poisoned, it having been recognised that the defoliation of the plants in the fruiting season is advantageous for checking the ravages of the boll-weevil. It is common to see large tracts of cotton completely defoliated in Texas in September, and there is a distinct odour given off from these places which is unmistakable.

10. "The Egyptian Cotton Worm" (*Prodenia littoralis*, Boisd.) is found throughout the tropical and sub-tropical zones of the Old World. In Egypt it attacks cotton and berseem, and three or four broods occur from June to August. The *eggs* are laid upon the lower leaves of the cotton plants, and are always in batches of some hundreds together, covered with light-brownish down. The eggs are yellowish, round and flattened, and by means of their characteristic covering are easily distinguished from those of any of the other pests hitherto mentioned. In

Egypt the *larvæ* hatch out in three to four days, and keep together on one leaf for the first day or two. They grow rapidly, and in from eighteen to twenty-two days are ready to change to pupæ. The colour of the full-grown larva is generally purplish to greenish brown, with broad darker brown longitudinal bands throughout the whole length, upon which are placed nine darker spots, sometimes with whitish specks below; above the brown band are black triangular patches on the third, fourth, fifth and twelfth segments, the largest being those upon the fifth and twelfth; the spots on the third and fourth are sometimes white-pupilled. The *pupa* is formed in the soil in a mud cell and is reddish-brown. The *moth* emerges, in Egypt, in from eight to ten days. It is a handsome insect, being usually pale-brown with rosy or violaceous suffusion and a conspicuous pale oblique bar on the forewing, and having the hindwing opalescent white with a dark line along the edge.

An account of the remedial measures adopted for dealing with this pest has already been given in this *Bulletin* (1906, 4. 51).

Although common in most parts of India, this species does not appear to be complained of as a pest on cotton there. A nearly allied species has occasionally been found to do some damage in the cotton States of America.

11. "The Cotton Boll Cutworm" (*Prodenia ornithogalli*, Guen.). This species is so nearly allied to the last that the only difference of importance lies in the *caterpillar* having triangular black spots distinctly developed on each segment. A careful comparison of the two species in the British Museum collection shows that there is probably no constant character by which they can eventually be kept separate. The pest is said to eat the foliage and bore into the squares and bolls, but no record exists of serious damage being done by it upon a large scale.

12. "The Garden Web-Worm" (*Loxostege similalis*, Guen.) which is common in the Southern States of North America is sometimes termed "the careless worm," from its normal food being the "careless weed" (*Amaranthus*). The larvæ spread from this weed to the cotton fields and often do considerable damage. The *eggs* are laid upon the leaves of the food plant in small batches and hatch in about three days. The young *larvæ*

feed upon weeds of different sorts and upon alfalfa if present. The full-grown larvæ are slightly over an inch long, of a yellowish-green colour, and covered with shiny black warts each bearing a bristle. The *pupa* is formed in the ground and the *moth* emerges in eight days; the total time from the laying of the egg until the emergence of the moth being one month. The moths are small yellowish-brown insects expanding only about three-quarters of an inch. The larvæ do most damage to young cotton, feeding on the leaves while themselves covered by a silk webwork, with which they envelop the shoots.

Remedial measures suggested are winter ploughing and the application of Paris green when the caterpillars first make their appearance.

13. "The Cotton and Berseem Worm" (Egypt), "The Beet Army Worm" (United States of America)—(*Caradrina exigua*, Hübnr.), has been recorded as occurring in Europe, Egypt and South Africa, North and South America, throughout the Oriental region, Honolulu.

The *egg* is yellowish-green, somewhat conical in shape and has a number of ridges radiating from the centre. The *larvæ* vary from green to pinkish-brown, have three longitudinal darker lines on the back, and are about one inch long. The *pupa* is formed beneath the surface of the ground, and the *moth*, which emerges in a few days, is brown with two kidney-shaped spots on the forewing, and with the hindwing pure white. It is, probably, only a night flier.

The larvæ are recorded as a serious enemy to sugar beets in Colorado and California and have been found in northern Texas, damaging the leaves and flower-buds of cotton. In Egypt the pest occurs in the winter months on "berseem" (Egyptian clover), and effects considerable destruction; the subsequent broods infest cotton, but are probably kept in check by the irrigation of the ground during the pupa stage. In America, it does not appear to have done so much damage to cotton as in Egypt.

The remedial measure employed in the former country seems to be the application of Paris green, but in Egypt picking off the caterpillars and flooding the ground are the methods adopted.

14. "The Salt Marsh Caterpillar" (*Estigmene acræa*, Dru.). The damage done by this insect in the United States is not very great, but the larvæ feed upon cotton, and, as they are said not to be susceptible to the action of arsenical poisons when nearly full grown, it is possible that they may become a serious pest. The insect occurs in North and Central America, but is not recorded from the West Indies. The normal food plant is *Plantago*. The *eggs* are laid in clusters upon the surface of the leaves, and the *larvæ* are at once distinguishable by being covered with long black hair upon the back, and reddish hair upon the sides. The *pupa* is usually formed in a cocoon made of leaves of the food plant, but is sometimes found under dried leaves and rubbish on the ground. The *moth* has the forewing flesh-coloured with numerous black dots; the hindwing being orange with three or four spots. Four generations of this insect are said to occur during the year in Texas. The remedial measures adopted are the application of Paris green in the early stages, and the destruction of the caterpillars by hand-picking.

15. "The Large Tiger Moth" (*Apantesis arge*, Dru.) occurs in the Atlantic States and California and has been commonly found upon cotton, but never as a serious pest. The *larva* is very similar to the one last described, but the *moth* has the forewing black with pink stripes and the hindwing whitish tinged with pink towards the base, and with black spots outwardly.

16. "The Fall Army Worm" (*Laphygma frugiperda*, S. & A.). Dwight-Saunderson remarks that occasionally the larvæ of this insect stray into cotton fields when they become excessively abundant in the late summer or early autumn, and sometimes do local injury. It can scarcely be considered as more than of accidental occurrence, and is therefore not of importance. It inhabits North America and the West Indies.

17. "The Io Moth" (*Automeris io*, Fabr.). The green spine-covered caterpillar, although doing but little damage to cotton, when found on it is dangerous to handle, as the prick of the spines is poisonous. It is found in the Southern States of North America.

18. "The White-lined Sphinx Moth" (*Deilophila lineata*, Fabr.). Occasionally this species becomes very numerous in

the United States, and in certain localities has been known to destroy all low-growing vegetation. The *larvæ* are either black with yellowish spots, or yellowish-green with black eye-spots and faint stripes. There is a pointed horn at the end of the body. The *pupa* is formed beneath the ground, and in this stage the insects pass the winter. The larvæ, which are very large and conspicuous when full grown, are so largely parasitised by a tachinid fly that few emerge in the second brood. The *moth* is brownish with white veins to the forewing and a white band from the tip to the base of the same wing: the hindwing is pinkish and bordered with dark brown.

The favourite food seems to be purslane, although many other weeds are devoured. A thorough deep ploughing in the winter will effectually destroy both the pupæ in the soil and the weeds which form the normal food.

III.—Lepidopterous Insects which Attack the Stems.

Stalk-boring lepidoptera are not common on cotton, but it is probable that a few more species will be recorded at a later date.

19. "The American Stalk-boring Caterpillar" (*Papaipema nitela*, Guen.). The damage done by this insect never amounts to more than the destruction of two or three plants in a field. The *larva* is at first black with white stripes, afterwards becoming whitish. It makes a hole in the main stem of the cotton plant near the ground, and lives by feeding upon the internal pith. Its normal food, however, is the blood weed. The *moth* is brown with a crested back, and with a pale line across the outward portion of the forewing.

IV.—Lepidopterous Insects which Attack the Young Plants.

The last form of pest of this group to be considered is that which attacks the cotton plant as soon as it appears above the ground. These insects are generally termed "cutworms" and are universally distributed.

20. "The Universal Cotton Cutworm" (*Agrotis ypsilon*, Rott.)

has been recorded from Europe, North and South America, Asia, Africa (Egypt and Natal), Java, Australia, New Zealand and Hawaii.

The *eggs* are laid singly, and are yellowish, becoming darker before hatching. The *larva* is brownish-grey to greasy leaden-brown, the head light-brown with a central dark band, and there are several pale lines upon the back and sides. It feeds on many species of plants, and prefers the young shoots just when they make their first appearance above the ground. The *pupa* is reddish-brown and in Egyptian cotton fields may be found upon the higher parts of the ridges in a mud cell just beneath the surface. The *moths* have the forewings ochreous sprinkled with brown, with several black-ringed irregularly-shaped spots with wavy lines from them. The hindwing is generally transparent white with brownish veins.

Winter ploughing destroys the pupæ to a large extent. Cabbage leaves dipped in a liquid arsenical mixture and spread about in the infected fields, are very useful for destroying the larvæ. The habit of these caterpillars is to feed at night, and to shelter under dead or fallen leaves or in crevices in the soil during the day. They take advantage of the leaves which are spread about and are killed by the arsenical solution.

21. "The Indian Cutworm" (*Euxoa segetis*, Schiff) has been observed in Europe, Asia, East Africa, Canaries, Madeira and South Africa. The same damage is done to cotton and other crops in India by this insect as by the last, except that this being more an underground feeder destroys the roots as well as the young shoots. The *larva* is pale-grey or greyish ochreous, sometimes tinged with pink and with dark-edged longitudinal lines down the back and sides. The head has two brown marks upon a paler ground colour. The *pupa* is formed beneath the ground in a cell. The *moth* is smaller than *Agrotis ypsilon*, and has no distinct cross-lines on the forewings running from the spots to the margin.

Ploughing up the soil in the winter is effective in destroying the pupæ.

22. The "American Shagreen Cutworm" (*Feltia malefida*, Guen.) occurs throughout the American continent and islands.

The *larva* of this is similar to the last, but has a broad pale

band down the back. The moth resembles *Agrotis ypsilon*, but has the front part of the thorax black. The ground colour of the wings is paler, and the forewing has a distinct toothed black patch near the outer margin. It occurs with *Agrotis ypsilon* and can be operated against in the same manner.

23–25. *Feltia annexa*, Treitschke, is said to be responsible for similar damage, as well as *Agrotis c-nigrum*, Linn., and *Plusia rogationis*, Fabr.

V.—HETEROPTEROUS RHYNCOTA: SAPPERS AND STAINERS.

This group includes the "sappers" and "cotton stainers" belonging to that division of insects furnished with a sucking, jointed beak, *Rhyncota*. The order of *Rhyncota* is sub-divided into *Heteroptera* and *Homoptera*, the former of which contains the flower and plant bugs, and the latter the scale insects and cicadas.

"Large Cotton Stainers" (*Dysdercus spp.*). The following species have been recorded from various parts of the world as affecting the cotton fibre by staining it, or by sapping the juice from the immature bolls or buds, so that they do not produce good cotton. There are a great number of species which have been suspected of doing this damage, but those which have actually been observed are enumerated below, with the localities in which they occur.

26. *Dysdercus andreæ*, Linn.—Cuba, Jamaica, San Domingo, St. John, St. Kitts, Nevis, Antigua, Montserrat and Guadeloupe.

27. *Dysdercus delauneyi*, Lethierry.—Montserrat, Guadeloupe, Dominica, Martinique, St. Lucia, Barbados, St. Vincent, Grenadines, Grenada.

28. *Dysdercus howardi*, Ballou.—Trinidad, Tobago.

29. *Dysdercus suturellus*, Herr Schaff.—South Carolina, Georgia, Alabama, Florida, Bahamas, Cuba, Porto Rico, Bahia (Brazil).

30. *Dysdercus ruficollis*, Linn.—Mexico, Brazil, Peru.

31. *Dysdercus cingulatus*, Riley.—India and Ceylon.

32. *Dysdercus nigrofasciatus*, Stål.—West Africa.

All these bugs are red and black, but vary from each other in their markings. The earlier stages, before the insect has begun

to develop the hemelytra or wing covers, are passed inside the ripe cotton bolls; the younger forms are often brilliant scarlet or crimson. There are no distinct changes similar to those found in Lepidoptera, the wings growing gradually as the insect gains in size. Owing to the presence of the young inside the opened cotton bolls, they are often gathered with the lint and crushed in the process of ginning, thereby causing a stain, but stains are also produced by the excrement of the mature insect. The female bug deposits her eggs in the cotton, the small bugs soon emerge and commence to feed upon the seed, sucking the juices from it. Afterwards they puncture the unripe bolls left on the plant and destroy the cotton inside while it is yet in a gelatinous form. *Dysdercus nigrofasciatus* in West Africa sucks the juices from other insects, and has been found feeding upon a small moth larva (unidentified) which was tunnelling into the seed. Mr. Ballou, Entomologist to the Imperial Department of Agriculture for the West Indies, says that the species there suck the sap from tender parts of the plant, thereby reducing the vitality and checking the growth of bolls and cotton.

Baits of cotton-seed or sugar-cane, placed in heaps upon the ground when most of the crop has been harvested, will attract numbers of the pests, which can then be destroyed with kerosene or boiling water. Shaking the insects off the plants in the flowering season into a bucket containing water with a little kerosene in it has also been found useful.

Numbers of the insects are invariably found infesting the pods and fibre of the silk cotton trees (*Eriodendron anfractuosum*, *Bombax malabaricum*, *Bombax heterophyllum*).

33. "The Cotton Leaf Bug" (*Calocoris rapidus*, Say.). This insect has long been known as a common one in cotton fields in some parts of the United States, but until recently has not caused, or been recognised as the origin of, great injury. In 1904, considerable damage was done by it in Northern Texas, where the puncturing of squares and bolls, resulting in their decay, was traced to this species. The punctured bolls have the appearance of being marked with black spots, resembling diseased places, which gradually become larger and depressed. In the end, the bolls either shrivel up without opening or decay

in one or more cells. The *bug*, when small, is green marked with red, afterwards becoming light-brown with bright red spots just beyond the middle of the wing.

No remedy has as yet been devised, but shaking the insects into a bucket as suggested for *Dysdercus* should prove useful.

34. "The Green Stink-Bug" (*Nezara hilaris*, Say.). This is a much larger insect than the last and is broader in proportion to length, being shaped somewhat like a shield. It is a most destructive insect upon fruit crops in the United States, and punctures cotton bolls in the same manner as *Calocoris*. As its name indicates, it is bright-green, and is therefore inconspicuous when on the plant. It emits a disagreeable odour when disturbed.

35. "The White-barred Leaf-footed Plant-Bug" (*Leptoglossus phyllopus*, Linn.).

36. "The Plain Leaf-footed Plant-Bug" (*Leptoglossus oppositus*, Say.). These two bugs are distinguished from the others mentioned by the inflated form of the joints of the hind-legs, which, owing to their serrated edges, have the appearance of fragments of leaves. *L. phyllopus* is narrow and has a yellowish-white bar across the back. *L. oppositus* is broader and has no such bar. They breed upon thistles, and do much harm to fruit besides occasionally attacking cotton bolls in many parts of North America.

37. "The Red-spot Stink-Bug" (*Pentatoma ligata*, Fabr.). This much resembles *Nezara hilaris* in form, but is smaller and of an olive colour with a scarlet spot in the middle of the back between the wings. It is found in the United States on cotton, puncturing the bolls.

Two other bugs of this class are frequently found in large numbers especially in Texas, and do some damage to cotton. These are—

38. *Largus succinctus*, Linn.—Texas.

39. *Jadera hæmatoloma*, H. Schaff.—Southern cotton States of North America.

They are like *Dysdercus* in form, but are described as of a slaty or bluish colour, margined with yellow or red.

There are probably many other species of bugs of this class which damage the bolls, but observations upon them are at present incomplete.

VI.—HETEROPTEROUS RHYNCOTA WHICH ATTACK THE SEED.

None of these have yet been recorded on cotton in America, but several species are found in Africa, and one occurs in India. The first one to be brought to notice as a cotton pest was *Oxycarenus hyalinipennis*, which was found by Mr. Willcocks, Entomologist to the Khedivial Agricultural Department, Cairo. In Egypt these insects are said to infest chiefly those bolls which have been damaged by the boll-worm. They are thus enabled to enter the boll and suck the juices from the unripe seeds. Owing to the numbers which infest the cotton damaged in this way, a few remain to enter the gins, and being crushed, stain the cotton. For this reason the name of "the lesser cotton stainers" has come to be applied to them. The insects do not naturally emit any staining liquid, and as they are easily expelled from the seed cotton before ginning, by spreading the latter in the sun, there should not be much damage done by them in this respect. The destruction of cotton seed by them is considerable, however, and they therefore better merit the name of "the cotton seed bugs." This name is now applied to the following species.

40. "The Egyptian Cotton Seed Bug" (*Oxycarenus hyalinipennis*, Costa). A small blackish insect with transparent wing covers, and with the second joint of the antennæ pale-reddish. In the younger stages the insect is altogether reddish-brown.

It has been found commonly in Egypt, but has not been observed in the Egyptian Sudan.

41. "The West African Cotton Seed Bug" (*Oxycarenus gossipinus*, n. sp., Distant).

42. "Dudgeon's Cotton Seed Bug" (*Oxycarenus Dudgeoni*, n. sp., Distant). Both these latter are new species which were found by Mr. Dudgeon infesting cotton bolls at different places upon the West Coast of Africa. All three species occur at Moyamba, Sierra Leone, and the two last were particularly numerous at Labolabo, Gold Coast. They are easily distinguishable from one another in the following ways.

Oxycarenus hyalinipennis. Transparent wing covers (hemelytra), second joint of antenna pale.

Oxycarenus Dudgeoni. Transparent wing covers, broadly black at the base, second joint of antenna dark.

Oxycarenus gossipinus. Straw-coloured wing covers, reddish pronotum (segment just behind the head).

The eggs of all these species are found in the cotton, and are easily conveyed from place to place with cotton seed. As the insects do so much damage in the destruction of seed, they may be looked upon as a dangerous pest. At Labolabo they became such a nuisance in the houses on the cotton plantation, that sleeping in these at night was found impossible.

The immature forms puncture the ripe as well as the unripe seed and destroy the contents.

43. "The Dusky Cotton Bug" (*Oxycarenus lactus*, Kirby) has been observed by Mr. Maxwell-Lefroy on cotton in many parts of India, and is identical in habits with the African species mentioned above. Mr. Maxwell-Lefroy says, "The eggs are laid in the lint close to the seed; each egg is cigar-shaped, of a bright yellow colour when first laid. They are laid in batches of six to ten at a time." The immature form is at first bright-orange changing to brown. The perfect insect is nearly black, with transparent hemelytra.

VII.—HOMOPTEROUS RHYNCOTA.

Among the Homopterous Rhyncota, numbers of insects have been accused of doing damage. The evidence against them, however, is at present insufficient, although the fact that many of them are found commonly upon cotton stems, coupled with the knowledge that it is the habit of some in the earlier stages to sap the juices of young shoots, makes it appear likely that some damage may be done to cotton by them. The insects referred to are the following species, which are commonly found in the cotton States of America.

44. *Homalodisca triquetra*, Fab. 45. *Oncometopia undata*, Fab. 46. *Oncometopia lateralis*, Fab. 47. *Aulacizes irrorata*, Fab.	"Cotton Sharpshooter or Dodger."

The insects are about $\frac{3}{8}$ to $\frac{1}{2}$ inch long, and have immense heads and transparent wings, sometimes spotted. They have

the habit of running round to the opposite side of a stalk to that from which they may be approached, and of jumping away quickly when an attempt is made to secure them.

48. *Æcanthus niveus*, De G. "The Snowy Tree Cricket," Texas.

This is suspected of similar attacks, although it has as yet only been found to be beneficial in devouring *Aphides* (plant lice). It is a snow-white hopping insect of small size.

49. An unidentified *Coccid*, covered with white easily detachable soft flakes, occurs at Moyamba on cotton plants and probably saps the juice of the stems. The specimens procured by Mr. Dudgeon were all of an immature form, and the pest was not found in other parts of West Africa.

50. *Aphis gossypii*, Glov., "American Cotton-Plant Louse."

51. *Aphis sorghi*, Theob., "Asal Fly" or "Dura Aphis" (Egyptian Sudan).

The American species is found on cotton in the United States and the West Indies; it is dark-grey in colour; that from the Egyptian Sudan attacks "Dhurra" (Sorghum millet) and is green. The latter has been found on cotton at Kaddaro, north of Khartoum. Both species swarm upon the terminal shoots and feed upon the juices, often doing considerable damage. The common ladybird beetles are well known to feed upon these insects wherever they occur. From the Sudan, two species of these small beetles are recorded by Theobald: *Cocinella undecimpunctata* and *Chilomena vicina.*

In America, spraying with kerosene emulsion, whale oil soap or tobacco water is employed as a remedial measure.

VIII.—DIPTERA.

Two-winged flies of the order *Diptera* are not to be expected to be recorded among the insects damaging cotton.

52. A red maggot, however, is mentioned by Ballou as destructive to the cambium or inner bark of the stem, generally where a wound has been made. The fly itself has not yet been identified. The damage does not appear to be great, and the insect has up to the present only been found in Barbados.

IX.—HYMENOPTERA.

Four-winged insects belonging to the order *Hymenoptera* (ants, bees, wasps, parasitica and saw-flies) seem to include few insects doing harm to the cotton plant, but many beneficial ones.

53. "The leaf-cutting ant" (*Atta fervens*, Say.) is said to do injury in some parts of Texas and the adjoining States, owing to its habit of biting off pieces of the cotton leaves to store in its nest. The leaf thus stored forms the matrix for the growth of a minute fungus upon which the ants feed their larvæ.

One suggested remedy is the sprinkling of Paris green round the entrances to the nests, and another is the injection of carbon bisulphide into the holes, which are then closed up.

X.—NEUROPTERA.

It is difficult to point to any direct injury done to cotton by members of the *Neuroptera* (including the *Termitidæ* or white ants). Fields may show vacant patches owing to the presence of the nests of *Termites*, but healthy plants in their vicinity do not appear to suffer from the attacks of the insect. Among the other forms of *Neuroptera*, mention may be made of the "lace-wing" flies (*Chrysopa spp.*) which assist materially in the destruction of *Aphides* (plant lice).

XI.—ORTHOPTERA.

The order *Orthoptera* (including locusts, grasshoppers, crickets, mantidæ and cockroaches) contains some rather important pests.

54. "The American Locust" (*Schistocerca americana*, Fab.).

55. "The Egyptian Locust" (*Schistocerca peregrinum*, Fab.).

56. "The Sudanese Locust" (*Acridium hieroglyphicum*, Fab.).

57. "The Lubber Grasshopper" (*Brachystola magna*, Gir.).

58. "The Differential Locust" (*Melanoplus differentialis*, Thos.).

The first and the last two of these are American, and sometimes do great damage to the young cotton fields. The young forms hatch out in uncultivated portions of land adjoining cotton farms, and quickly devour the young cotton as soon as it shows above the ground, rendering a number of replantings necessary. The full-grown insects also do considerable damage. Paris

green is used for their destruction, as well as little heaps of bran-mash sweetened with molasses and poisoned with arsenic.

The Egyptian and Sudanese locusts have done enormous damage during recent years to the cotton crops of the Sudan and in earlier years to those of Lower Egypt. In the Sudan in 1905, three or four successive plantings of cotton were ruined. The destruction of the insects is effected by driving them into pits and burning them.

59. "The Large Indian Cricket" (*Schizodactylus monstruosus*, Drury). This insect damages young crops of all kinds in different parts of India, and has probably caused injury to cotton in the Punjab.

XII.—COLEOPTERA.

The next order *Coleoptera* (beetles) contains several minor pests, and at least one very serious one, which will be noticed first.

60. "The Mexican Boll-Weevil" (*Anthonomus grandis*, Boh.). The damage done by this insect to cotton in Texas in recent years has been so enormous that in many places cotton planting has been abandoned altogether. It is estimated that in 1904, 900,000 acres, representing a normal production of 350,000 bales, became infested for the first time, bringing the infested area in the United States up to the end of that year to about 32 per cent. of the total cotton acreage. It is also estimated that the loss sustained by boll-weevil ravages in 1903 amounted to about $15,000,000 and in 1904 to about $22,000,000.

The introduction of an early fruiting cotton which yields most of its crop before large numbers of the insects have come into existence, has recently checked the damage, but it has been found impossible to prevent the insect extending northward. It is thought that it will eventually overrun most of the cotton belt where the winter temperature does not fall sufficiently low to kill the hibernating forms.

The life-history of the insect is as follows:—

The *egg* is laid in a cavity which the female forms by eating into the cotton flower-bud or fruit. It is ovoid in shape and is deposited, normally, deep in the cavity, generally upon the immature anthers of the bud or upon the inside of the carpel of

the boll. The holes made for the purpose of egg deposition are not generally those made for feeding, but are specially prepared for the reception of the egg, and are sealed up with a mixture of mucus and excrement. If, by chance, the egg is accidentally laid outside the hole, the female insect nearly invariably devours it at once. The *larva* emerges after a few days as a whitish grub, with a brown head, and without legs. In the autumn the average time taken for complete development of the larva is from 6 to 12 days, but later (November–December) 20 to 30 days may be required. Squares in which the boll-weevil larvæ are feeding always fall to the ground, but when the egg has been laid in the fruit it is unusual for one larva to attack more than one lobe of the boll. One of the effects noticeable in the infested squares is what is termed "flaring," the involucre spreading out and exposing the bud. The seeds in the boll, or the anthers and soft part of the flower, are those which are eaten by the grub, and the lint, although destroyed, is not generally used as food. The *pupa* is formed in a cell made of excrement. It is at first creamy white and shows all the appendages of the perfect insect, or rather the sheath for such appendages. The duration of this stage is, according to temperature, from 2 to 16 days, and the pupa gradually changes to dark brown during the formation of the mature insect within the sheaths. The *weevil beetle* emerges from the square or boll by cutting a hole large enough to get its body through, and in the first instance it is more or less soft. As it hardens by exposure it changes from an orange-brown to a deep chocolate. The mandibles are placed at the end of a curved rostrum or beak, and the antennæ rise from points upon either side of this, about one-third from the end. The weevils themselves do much harm to flower squares and bolls by puncturing them and causing the contents in many cases to decompose.

Insects which are parasitic upon the weevil include two small *Hymenoptera*, *Bracon mellitor*, Say., and *Bracon dorsata*, Say. A mite, *Pediculoides ventricosus*, Newp., occasionally infests the larva. An ant, *Solenopsis geminata*, Fab., from Guatemala is predatory upon the full-grown weevil, but it is not known whether it is possible to introduce this successfully into Texas, where the winter climate is more severe than that of its usual habitat.

Many birds have been found to feed upon boll-weevils, but not in sufficient numbers to be of much importance.

Many remedies have been suggested, but few have done much to improve the condition of the infected areas. The expense of the application of Paris green has not been compensated by the number of insects destroyed. The application of jets of steam into railway cars, containing seed mixed with live weevils, resulted in their death in 10 minutes to a depth of $1\frac{1}{2}$ inches in the seed mass. Carbon bisulphide has also been used as a disinfectant for seed, for although it is not considered probable that the weevil can be conveyed with the seed for any distance, it can never be guaranteed that this is impossible. It is said to be doubtful whether a thorough treatment with carbon bisulphide would destroy weevils so thoroughly protected, as they have occasionally been found to be, in dried-up miniature cotton bolls, accidentally mixed with the seed. (Bull. No. 51, Bur. of Entomology, U.S. Dept. of Agric.). The effects of the weather and change of temperature have been ascertained to be of the greatest assistance in the destruction of weevils in all stages of development. For this reason encouragement is given to the cotton worm, in the fruiting season, to multiply and to strip the foliage from the plants, thus rendering the bolls more exposed to the sun, whereby the double effect is produced of early ripening, and the killing of boll-weevil grubs in the bolls and squares, by excessive heat. Unfortunately there is no other plant known upon which the boll-weevil feeds, so that there is no indication given of a possible trap crop. The most hopeful form of prevention of the occurrence of this insect lies in its exposure during the dormant period to conditions unfavourable to its existence. Ploughing, destruction of dry stalks and leaf refuse combined with the collection and burning of fallen squares, and the growth of an early maturing cotton, are the lines recommended to be followed, but nothing has yet been effected that has stopped the spread of the insect northwards in the United States.

61. "The Indian Cotton Stem Weevil" (unidentified).

This is an insect recorded by Mr. Maxwell-Lefroy from Behar as injurious to cotton stems. The grubs are said to tunnel in the stems near the ground and form a swollen lump, which does not necessarily kill the plant, but makes it liable to break off.

The weevil in its perfect form is frequently seen and is said to pass the winter season as a grub inside the cotton stems. This fact should render its destruction easy.

62. "The Cowpea Pod Weevil" (*Chalcodermus æneus*, Boh.).

This insect has been observed eating stems of young cotton and squares in Texas, Louisiana and Georgia.

63. "The Acorn Weevil" (*Balaninus victoriensis*, Chitt.).

64. "The Grey Beetle" (*Bruchus amicus*, Horn).

These two American beetles have been seen occasionally to attack cotton squares and shoots.

65. "The Click Beetle" (*Monocrepidus vespertinus*, Fab.) is a small insect frequently found attacking cotton blossoms and squares. The damage done, however, is of little consequence.

66. "The Wingless May Beetle" (*Lachnosterna lanceolata*, Say.).

67. " " (*Lachnosterna cribrosa*, Lec.).

68. " " (*Lachnosterna farcta*, Lec.).

These beetles often do serious damage to young cotton, upon which they feed in numbers from an hour before sunset until dusk, afterwards returning to the soil, in which they remain until the following evening. It has been noticed that they do most damage on lands where cultivation is deficient, and as a remedial measure ploughing is recommended. The larval stage is undergone beneath the ground, where the grub devours the roots of weeds and grasses.

69. "The Banded Blister Beetle" (*Epicauta vittata*, Fab.).

70. "The Parallel Striped Blister Beetle" (*Epicauta lemniscata*, Fab.).

71. "The Ashy Blister Beetle" (*Epicauta cinerea*, Forst.).

72. "The Reddish Blister Beetle" (*Epicauta ferruginea*, Say.).

Damage is done to the flowers by these insects in some parts of the United States, but chiefly the petals are eaten, the reproductive parts being generally left uninjured.

73. "The Indian Cotton Stem-Borer" (*Sphenoptera gossypii*).

Mr. Maxwell-Lefroy says with regard to this insect, which has been found plentifully in Bombay, Central Provinces, and the Punjab, that the larva, which is a long white grub, lives inside the stems, and may be detected by the yellowing or withering of a plant. The Indian cultivator weeds out these withered

plants, and places them in neat heaps about the field ; if he went a step further, as Mr. Lefroy remarks, and burnt the plants so collected, he would prevent the increase of the pest.

74. " The American Cotton Stem-Borer " (*Ataxia crypta*, Say.). This beetle belongs to the long-antennated group, many of which are destructive wood-borers in the larva state. Up to the present it has not been known to bore into healthy plants, the female only depositing her eggs upon wounded parts of cotton stems. Its effect is similar to that of the Indian borer.

This completes the list of the insects commonly found doing damage to cotton, although many others, probably on insufficient evidence, have been recorded as doing so. There are still a few insects, chiefly of the stainer class, which have been noticed in East Africa, and which are possibly distinct from those mentioned in this article. Mr. Lefroy mentions an *Aphis* and a *Jassid* (leaf-hopper) from India as occurring on cotton ; but these have not yet been named.

XIII.—MISCELLANEOUS.

Only one form of mite has been recorded as affecting cotton, and a short account of it is given below. *Mites* are not included under the *Insects*, but form a sub-division of the *Arachnoidea*, under the name of *Acarinæ*. *Arachnoidea* comprises the scorpions, spiders and mites, and this will give an indication of the position of these minute animals.

75. "The Cotton Leaf-Blister Mite" (*Eriophyes gossypii*, Banks).

A very full account has been given in the *West Indian Bulletin* of the damage done by this mite to the leaves of the cotton plant in Montserrat and St. Kitts. The attack is indicated by the crumpled form of leaf, which eventually produces a gall, at first of the same colour as the leaf, but later becoming reddish and then brown. The mite lays its eggs in these galls, which burst open and permit the young form to be distributed by the wind to other plants. The galls do not appear upon the leaves only, but may occur on any part of the plant. The mite itself is microscopic.

As remedies for this pest the destruction of " ratoon " cotton

is recommended, and the application of sulphur with or without lime.

A Nematode worm belonging to the group *Anguillulidæ* has been found damaging cotton in many parts of America, and as the species is distributed in many parts of the Old World also, where it damages other plants in a similar manner, it may be expected to occur upon cotton anywhere.

76. "Root Gall Worm," or "Eel Worm" (*Heterodera radicola*, Muell.).

The worms live in the root tissue, and form abnormal growths termed "galls." The transformations are complicated, and the mature forms differ largely according to sex. The male is thread-like and the female vesicular; both are encysted until the male is sufficiently matured to fertilise the female, when it breaks through the wall of the cyst and travels through the plant tissues to the female.

The effect on the plant is very destructive, but no remedy has yet been suggested, except the complete destruction of affected plants.

There are two recognised diseases of the cotton plant said to be due to bacteria, one of which is of considerable importance.

77. "Cotton Boll Rot" (*Bacillus gossypinus*, Stedman).

78. "Angular Leaf Spot" (*Pseudomonas malvacearum*).

The first is a short straight *Bacillus* with truncated, slightly rounded ends, usually solitary, but sometimes occurring in chains of three or four. It infests immature bolls, causing a decay of the undeveloped fibres. Very little is yet known about it.

The second is the cause of watery spots upon the leaves which subsequently become blackened. The disease hastens the fall of the leaves. Both pests are found in the cotton States of America, and *Pseudomonas malvacearum* occurs also in the West Indies.

THE SOURCES, MANUFACTURE AND INDUSTRIAL USES OF ALCOHOL.

DURING the last few years a considerable amount of attention has been given in this and other countries to the possibility of using alcohol as a source of power, and in Germany especially progress has been made in designing motors and heating and lighting apparatus intended for use with alcohol. The increasing use of engines in which a liquid fuel is almost a necessity has acted as a stimulus in this direction, especially as the supplies of low-boiling petroleum now generally made use of for this purpose are somewhat limited, and there is some prospect of their being unable to meet the demand for liquid fuels in the future. In addition, the use of alcohol in various chemical industries is increasing, and there is a tendency on the part of manufacturers to endeavour to obtain supplies of alcohol from new countries, and to avoid possible dependence for supplies on the rather restricted area in which cheap alcohol suitable for industrial purposes is now produced. There are two important factors governing the extension of the use of alcohol in the directions indicated. In the first place the difficulties attending its use as a source of power have not been entirely solved, and, further, its price is at present somewhat too high. The first of these obstacles will no doubt be overcome in time by the engineers, who are devoting attention to the subject ; and as regards the second, the matter is probably mainly one of organisation in manufacture, and there can be little doubt that the cost of production could be reduced by the use of cheaper raw materials, and by the organisation of manufacture on a larger scale with more efficient machinery than is at present customary in most countries.

The matter is of some importance in many of the Colonies and Dependencies of the British Empire, where starchy materials suitable for the manufacture of alcohol are grown in large quantities and where also there is a considerable local outlet for alcohol, for use as a fuel in agricultural and other machinery.

That planters and others in the Colonies are fully alive to the importance of this matter is evidenced by the inquiries which are

received at the Imperial Institute on this subject, and consequently it has been considered desirable to prepare a *résumé* of information available regarding the raw materials likely to be suitable for the manufacture of alcohol, and an outline of the processes in use for the conversion of starchy matters into this product. For this purpose the special *Farmers' Bulletins* (Nos. 268 and 269), published by the United States Department of Agriculture, and numerous other publications dealing with this subject have been largely drawn upon.

Sources of Alcohol.

The raw materials from which alcohol can be made consist of those crops which contain sugar, starch, gum, or cellulose (woody fibre), capable of being easily converted into a fermentable sugar. Of these materials the most important are starch and sugar, the quantity of alcohol produced from cellulose being so small as to be of no commercial importance at the present time.

The principal starch-producing plants are the cereals, the potato, and cassava. With the potato may be classed, though they are not botanically related thereto, the sweet potato, and the yam.

The chief sugar-producing crops are the sugar-cane and the sugar-beet, though considerable quantities of sugar are also obtainable from various plants having sweet fruits or juices, and waste fruit is frequently used as a source of alcohol.

Arrowroots.—The various plants known as arrowroots yield large quantities of starch suitable for the manufacture of alcohol; but, as these starches are valuable for other purposes, it is doubtful if this source of alcohol will ever be utilised commercially. This, of course, applies only to the true arrowroots, and not to such substitutes for them as "tacca starch," which is cheap enough to be used as a source of alcohol.

Artichokes.—The Jerusalem artichoke has been highly recommended and somewhat extensively used in Germany for the manufacture of alcohol. The crop may be harvested either in the autumn or in the spring. As the tubers keep well during the winter, and in a few places may be kept in hot weather, they form a raw material which can be stored for a long period,

and still be valuable for fermentation purposes. The fermentable material in the artichoke amounts to about 17 per cent., so that 100 lb. of artichokes would yield approximately $8\frac{1}{2}$ lb. of industrial alcohol.

Bananas.—The banana contains large quantities of starch and sugar suitable for alcohol-making. From 20 to 25 per cent. of the weight of the fruit consists of fermentable material, so that in countries where the banana grows in abundance it would be a cheap source of alcohol.

Barley.—A very important cereal in connection with the manufacture of alcohol is barley, which is quite universally employed for making malt, the malt in its turn being used for the conversion of the starch of other cereals into sugar in their preparation for fermentation. Thus malt is valuable, not because of the amount of alcohol that can be produced from it, but from the fact that in quantities of about 10 per cent. it is capable of converting the starch of the unmalted grains, whatever their origin may be, into the sugar maltose, which can then be fermented by yeast.

Unmalted barley, oats, rye, and other grains of the same type form the principal sources of the potable alcohol made in the United Kingdom.

Cassava.—Numerous analyses made in the United States Bureau of Chemistry and elsewhere show that the peeled root of cassava contains a little over 30 per cent. of starch, and that approximately 35 per cent. of the root is fermentable. These figures, however, represent a very high grade of cassava, and for ordinary roots an average of 25 per cent. may be taken. In the dry root there is nearly 72 per cent. of starch, and 17 per cent. of extract, principally sugar. Assuming that 15 per cent. of the latter is fermentable, it will be seen that over 87 per cent. of the dry matter of cassava is fermentable. It thus becomes, in a dry state, a source of alcohol almost as valuable, pound for pound, as rice (*Cf.* this *Bulletin*, 1903, **1.** 38).

Corn (Indian corn or maize).—Almost all the alcohol for beverages or for industrial purposes produced in the United States is made from Indian corn, and a considerable amount of maize is also used for this purpose in the United Kingdom. The fermentable matter in this material—that is, the part which is

capable of being converted into alcohol—amounts to nearly 70 per cent. of the total weight. A bushel of Indian corn weighs 56 lb., so the total weight of fermentable matter in a bushel, in round numbers, is 39 lb. The weight of alcohol produced under the best conditions is little less than one-half of the fermentable matter. Therefore the total weight of alcohol yielded by a bushel of average Indian corn would be, roughly, about 19 lb. The weight of a gallon of 95 per cent. alcohol being 7 lb., a bushel of corn would produce 2·7 gallons.

Potatoes.—Of all the common root crops, potatoes, including the yam and sweet potato, are the most valuable for the production of alcohol, that is to say, that they contain more fermentable matter, per 100 lb., than other root crops. The quantity of starch in ordinary potatoes varies from 15 to 20 per cent.; probably 18 per cent. might be stated as the general average of the best grades.

Although the potato is not sweet to the taste in a fresh state it contains notable quantities of sugar. This sugar is lost when the potato is used for starch-making purposes, but is utilised when it is used for the manufacture of alcohol. The percentage of sugar of all kinds in the potato rarely exceeds one per cent. The average quantity is probably about 0·35 per cent., including sugar, reducing sugar and dextrin, all of which are soluble in cold water.

Experience in Germany has shown that the liberal application of nitrogenous fertilisers increases the yield per acre of potato tubers, and consequently the total yield of starch to a very marked extent, although the average percentage of starch present is increased very little. Thus the average results of a number of experiments were: Without the application of nitrogenous manures—yield of tubers, 16,781 lb. per acre; yield of starch, 3,277 lb. per acre. With nitrogenous manures—yield of tubers, 19,629 lb. per acre; yield of starch, 3,856 lb. per acre.

The potatoes used for the manufacture of alcohol in Germany are not the same as the varieties raised for edible purposes. Systematic efforts have been made in that country for many years to grow a potato rich in starch, irrespective of its edible qualities. Some varieties in exceptional instances have shown as high as 29·4, 28·1, and 27·3 per cent. of starch. In warm,

dry seasons, potatoes are often obtained containing from 25 to 27 per cent. of starch; but the average content of starch in the potatoes used in the German distilleries is 18 to 20 per cent.

The following varieties of potatoes are considered in Germany the best for the manufacture of alcohol: Wohltman, Silesia, Agricultural Union, Athenena, Prince Bismarck, Richter's Imperator and Maercker.

Under the most favourable circumstances, and with potatoes bred especially for the purpose, an average content of about 20 per cent. of fermentable matter may be reasonably expected. It is thus seen that approximately 10 lb. of industrial alcohol can be made from 100 lb. of potatoes.

Rice.—Of all the cereals, rice has the largest percentage of fermentable matter and it is extensively used in some tropical countries for making alcohol. The percentage of fermentable matter is nearly 78 per cent. A bushel of unhulled rice weighs 45 lb., and of hulled rice 56 lb. There are, therefore, about 34 and 43 lb. of fermentable matter per bushel, in unhulled and hulled rice respectively.

Rye.—Large quantities of alcoholic beverages are manufactured in America from rye, but this cereal is not used to any extent for making industrial alcohol. The percentage of fermentable matter is about 71 per cent.

Spelt.—This grain, which is botanically a variety of wheat, is of prolific growth. Under favourable conditions as many as 73 bushels per acre have been reported by the North Dakota Experiment Station in the United States, and analyses show 70 per cent. of fermentable carbohydrates in the grain. This crop appears to be worthy of consideration as a profitable source of industrial alcohol.

Sugar beets.—The sugar beet is largely used in Germany, France and elsewhere as a source of alcohol. About 18 gallons of alcohol are produced from each ton of sugar beets employed.

Sweet potatoes.—In the Azores great quantities of sweet potatoes are grown for making an alcohol of fine quality which is said to be used to a large extent in fortifying wines. Experiments in South Carolina have shown that as much as 11,000 lb. of sweet potatoes can be grown per acre. An average yield, however, would be 8,000 lb. The percentage of starch is

markedly greater than in the ordinary potato. In all cases over 20 per cent. of starch was obtained in the South Carolina sweet potatoes, and in one instance over 24 per cent. In addition to starch, the sweet potato contains notable quantities of sugar, sometimes as much as 6 per cent. being present. The total fermentable matter, therefore, may be reckoned at a minimum of 25 per cent. A bushel of sweet potatoes weighs 55 lb., one-quarter of which is fermentable matter, and would yield 7 lb. or a little over one gallon of alcohol.

In addition to the foregoing sources, reference should be made to the molasses obtained in preparing sugar from the sugar-cane, from which large quantities of alcohol are made in the West Indies, British Guiana, Mauritius and elsewhere, and which are also imported in considerable quantities into the United Kingdom and other European countries for the same purpose. Waste fruit and waste wines are also largely utilised for this purpose, and it is probable that in seasons in which there is an over production of such fruits as peaches, plums, apples, etc., which are rich in sugar, these might be profitably employed for making alcohol instead of being allowed to fall on the ground and rot as is frequently the case at present. In the United Kingdom the sugars present in carob beans have also been used for the manufacture of alcohol.

Manufacture of Alcohol.

The three principal steps in the manufacture of alcohol are (1) preparation of the "mash" or "wort," (2) fermentation by means of yeast of the mash drawn off from the mash tun, and (3) distillation of the dilute alcohol formed in the beer or wash from the fermentation tanks.

Mashing.—The object of this process is to reduce the starch in the ground grain or other material used to a thin paste, in order that the malt ferment subsequently added may act upon it readily and convert it into sugar. The cereals are usually ground between millstones and the flour mixed with water in the mash tun, the mixing being accomplished by means of a mechanical agitator. In the case of potatoes and similar materials, they are usually softened by steaming and then gradually broken up and mixed with water in the usual way.

If the mashing be done before the addition of the malt the temperature of the water added may be raised to that of boiling water. If, however, the malt be added before the mashing begins the temperature should not be allowed to rise above 140° F., since the fermenting power is retarded and disturbed at higher temperatures. (*Cf.* this *Bulletin*, 1905, **3**. 187.)

Fermentation.—The mash, after the starch has all been converted into sugar, is passed into fermenting tanks, and the yeast is added. These tanks often have a stirring apparatus whereby the contents can be thoroughly mixed with the yeast and kept in motion. This is not necessary after the fermentation is once well established, but it is advisable, especially in the early stages, to keep the yeast well distributed throughout the mass. In these tanks the temperature is varied according to the nature of the product to be made. In making industrial alcohol the sole object is to secure the largest possible percentage of alcohol without reference to its potable properties.

The conversion of the starch into a fermentable sugar may also be accomplished without the intervention of malt. This is done by heating the softened grain or other starchy material with a small amount of acid in autoclaves under pressure whereby it is largely converted into glucose, which can be fermented directly by yeast. In converting the sugar contained in sugar beets, fruits, molasses and similar materials into alcohol, it is merely necessary to get the saccharine matter into solution in water as quickly as possible, and for this purpose the beets or fruits are cut into thin slices and macerated in warm water until they are exhausted of their saccharine contents. The liquor so obtained is then fermented in the usual way with beer yeast.

Distillation.—The object of this process is to separate the alcohol contained in the fermented liquor from the non-volatile products and water with which it is mixed. The stills in use for this purpose are of numerous types, and their structure and method of action are too complicated to be discussed here, but in general it may be said that they are so arranged as to permit of a current of steam being driven through a falling column of the fermented liquor, which is thus gradually deprived of its alcohol, the latter being carried off by the current of steam, which

gradually becomes richer and richer in alcohol until finally on condensation it yields alcohol of the required strength.

It must be understood that the machinery in use for carrying out these various processes involved in the conversion of starch and sugar into alcohol has been brought to a high state of perfection, and that no adequate account of this side of the question can be given here. For fuller information on this matter the numerous books dealing with this phase of the subject should be consulted.

Denatured Alcohol.

The process of rendering alcohol unpalatable without interfering with its suitability for industrial purposes is called "denaturing," and consists, essentially, in adding to the alcohol a substance of unpleasant taste or odour or of intense colour. The denaturing substance must also be of such a character that it will not be readily removable from the alcohol by any usual process of purification.

Among the substances which have been proposed and used for this purpose are the following:—Shellac (with or without the addition of camphor, turpentine, wood spirit, etc.), rosin, copal resin, camphor, turpentine oil, acetic acid, acetic ether, wood spirit, pyridine, acetone, methyl acetate, methyl violet, methylene blue, aniline blue, eosin, fluorescin, naphthalene, castor oil, light petroleum, carbolic acid, musk, animal oils, etc.

A mixture of wood spirit and petroleum is the usual denaturing agent authorised in the United Kingdom and in the United States, but in most countries a variety of denaturing agents is now permitted so that the special needs of certain industries may be met, and in some countries pure alcohol is allowed to be used "duty free" in certain industries, strict supervision being of course insisted on.

Industrial Uses of Alcohol.

The principal uses of alcohol are for illumination, heating, motive power, and the manufacture of lacquers, varnishes, smokeless powder, vinegar, ether, chloroform, artificial dyes, synthetic perfumes and synthetic drugs and similar materials.

The most important of these uses so far as the planter is

concerned are those included in heating and illumination, and for these purposes alcohol is especially useful in localities remote from centres of the production of wood, coal, kerosene, or natural gas and oil, which are now the chief heating and illuminating agents. Stoves of many different kinds have been invented for burning alcohol for heating. In using alcohol for illumination it must be first vapourised, then burned in a state of gas, and the flame produced allowed to impinge on an ordinary incandescent gas mantle. The use of alcohol motors on plantations may perhaps become common, if the difficulties of construction are successfully overcome and if the price of alcohol falls sufficiently low. Alcohol can be used for almost all purposes for which petrol is at present employed, such as the driving of wagons, carriages, mowing machines, ploughs, and stationary motors for working machinery for chopping and grinding cattle food, water-pumps, etc. In many places the present relative prices of alcohol and petrol give no financial advantage in the use of the former, but when, as is probable, the price of petrol advances and that of alcohol falls, the latter may possibly become a valuable source of power.

GEOLOGICAL STRUCTURE OF TRINIDAD.

It was in the years 1857 to 1859 that Wall and Sawkins of the Geological Survey of the United Kingdom made a rapid survey of the geology of Trinidad, and their report is published in the *Memoirs of the Geological Survey*. The subsequent labours of Mr. Guppy in the field of paleontology have added much to our knowledge of the past of the island.

There still, however, remained considerable uncertainty with regard to many points in the interpretation of the geological structure of the island, and its resources in coal, asphalt, manjak, and petroleum. The Government of this Colony were therefore fortunate in being able to secure the services of Mr. E. H. Cunningham Craig, of the Geological Survey of the United Kingdom, who is now engaged in a detailed survey of its geological features and mineral wealth, with the help of the new 6″ topo-

graphical map. The following brief account of the results already obtained is extracted from the report of a lecture by him at the Victoria Institute of Trinidad and Tobago.

Little is known of the age of the metamorphic rocks of the range of mountains which follow the northern coast of this island, and Mr. Craig has not yet been able to give much time to their study. They are intensely folded by the operation of great horizontal earth-movements acting in a north-north-west and south-south-east direction. It is probable that it has developed a fan structure involving a repetition of beds and the occurrence of the same rock in different parts of the fan in totally different states of metamorphism, physical and chemical. The thickness of the strata, estimated by Wall and Sawkins at 10,000 to 12,000 feet, appears therefore to be excessive. This repetition is to be attributed to folding and not to faulting, though numberless minute faults, thrusts and dislocations of all kinds exist.

The strata of cretaceous age that succeed the highly folded rocks of the northern range are of various kinds, and though no great thickness is exposed there is evidence of considerable movement during their deposition. The lowest rocks exposed are soft banded sandstones, characterised by glistening flakes of mica ; these are followed by sandy clays, which become finer as one ascends in the series, while at a still higher horizon thin beds of limestone make their appearance. During the deposition of these strata the ground was slowly depressed on the north-west and elevated slightly towards the south-east. This flexuring movement brought the strata in the latter direction nearer the surface, so that ultimately a group of coarse siliceous sandstones was deposited upon a slightly eroded surface of limestone.

The movement, which appears to have continued to a later period, involved considerable earth stresses in a north-west and south-east direction, though not so intense as those which had affected the rocks of the northern range. The cretaceous strata are consequently flexured sharply and frequently on north-east and south-west axes, not only in Trinidad, but in Barbados and other islands and on the mainland. Some of the ridges thus formed were small and fairly sharp, while others were broad with more gentle contours. They constituted great masses of

land, which extended both to the east and west of what is now Trinidad.

The tertiary rocks were laid down on the irregular eroded surface of the older rocks. They accumulated to a depth of six or seven thousand feet, beginning with shallow water deposits, and gradually enveloping the ridges of cretaceous strata from the waste of which most of their material is derived. While this deposition proceeded, flexuring movements took place on east and west axes, the direction being probably determined by the massive barrier of the northern range. These movements also were wide spread, as is proved by evidence from Tobago, where a similar barrier exists, and from Barbados, where they had distinct, if less striking, effects. In Trinidad the motion was from the south obliquely across the former north-west and south-east movement, and the present structure is a compromise between the two. Ultimately the tertiary beds were traversed by a series of well-defined anticlines and synclines.

The most southerly anticline passes from Galeota Point across Guayaguayare Bay, and then continues inland parallel to the coast to a point west of Majawal River where it again disappears beneath the sea, continuing, however, close to the land and intersecting Chagonary and Islet Points. Finally it emerges at Galfa Point, and traverses the south-west promontory of the island. The fold is sharp, the rocks on the southern side being frequently vertical.

Another anticline starts as a gently sloping saddle about half-way up Mayaro Bay, but quickly becomes steep and sharp, and curves south-westward to a point near the head of the Lizard River. Further on it crosses the Moruga Road near Rock River, and, passing north of Siparia to Point Fortin, runs into the Gulf of Paria. A small intermediate anticline occurs between Erin and Siparia.

A third great anticline starts north of Mayaro Point and runs through Pool and Hindustan and South Naparima, emerging as a gently sloping fold at the Vance River. Local subsidiary parallel flexures occur near Princes Town, but cannot be traced far. A fourth anticline is seen at San Fernando, and the central range marks roughly the course of yet another great flexure

Finally an important monoclinal flexure, which appears about Point Noir, has been traced west and west-south-west for upwards of six miles.

These flexuring movements brought up ridges of tertiary rocks into the zone of denudation, and one accordingly finds near La Brea and Oropuche the youngest tertiaries lying unconformably on the denuded edges of the older. The irregularities of their folding are due to a compromise between the post-cretaceous and subsequent movements, the underlying ridges of cretaceous strata causing divergences from the general direction of the latter flexures. The north and south movement abutting on north-east and south-west barriers caused lateral stresses and occasional fractures, which occur almost invariably in the neighbourhood of outcrops of cretaceous strata. Thus there are a series of step faults in the Cunapo coal field, which are largely lateral displacements along more or less vertical planes. They die out when traced northward.

There is evidence that the movements that gave rise to those flexures are still continuing, the anticlines being marked by recently elevated beaches or alluvial tracts and the synclines by swamps.

The geology of Trinidad is characterised by marked lateral variations in the character of the beds, such as are to be expected on the margin of a continent. In one place the strata indicate the occurrence of estuarine conditions with lagoons and perhaps even land surfaces, while elsewhere there is evidence of deep clear water with small islands. In some localities there were coral reefs, in others deposits characteristic of shallow muddy water; and there are even indications of oceanic conditions. All of these deposits appear to be of more or less the same age. The Moruga series of Wall and Sawkins represents, chiefly in estuarine phase, the whole of the tertiary strata, 6,000 to 6,500 feet in thickness. The Caroni series of the same authors corresponds to the upper part of the Moruga, while the Tamana represents its lower portion, but possibly reaches down to a slightly lower horizon. Their Nariva series includes a number of clays of different ages, while the Naparima marl, which was believed to be low in the tertiary is really fairly high and never approaches within 2,500 of the lowest tertiaries seen in

the island. These conclusions obtained by stratigraphical work are confirmed by fossil evidence.

On the crests of the anticlines the oil-bearing beds approach or even reach the surface; the centre lines of the anticlines are therefore marked almost everywhere by indications of oil, which does not occur sporadically or in pockets, as some have supposed.

From Guayaguayare to Cedros, from Mayaro Bay to Point Fortin, and from Mayaro Point to the mouth of Vance River the petroleum of the lower beds makes its presence evident by pitch deposits and seepings of oil or mud volcanoes, while there are higher oil horizons, which have a less extended distribution. More detailed information regarding the petroleums and pitch deposits of Trinidad is given in this *Bulletin*, 1903, **1.** 177, 180; 1904, **2.** 175, 19; 1905, **3.** 32; 1907, **5.** 198, 199.

The author believes that the districts of Chatham and Irois may in time furnish sufficient lignitic fuel for all local purposes, and support a patent fuel industry. Manjak may be worked throughout the length and breadth of the Guaracara Valley and oil will probably be struck some day near the line of the northern range, most likely in the ground between Arima and Matura.

ALLUVIAL TINSTONE DEPOSITS OF NORTHERN NIGERIA.

THE alluvial tinstone (cassiterite) deposits of Northern Nigeria occur in the south-west part of the province of Bauchi, in the neighbourhood of the river Delime, the water of which flows north-east towards Lake Tchad. This tinstone-bearing district is some 220 miles north-east of the town of Lokoja, which is situated at the confluence of the rivers Niger and Benue.

The land of the Bauchi province, and also in part that of the surrounding provinces, comprises the most elevated portion of the Protectorate. The town of Bauchi, which is itself about 3,000 feet above sea level, is practically at the centre of the province. It is also approximately the centre of a mountainous

district which covers altogether an area of about 50,000 square miles. This elevated tract of country consists for the most part of a gneissic plateau, which is freely cut by dykes of dolerite and basalt, while extensive intrusions of granite form the more conspicuous hills.

The tinstone alluvium, as far as is at present known, is restricted to the comparatively small area comprised by the plateaux of Tilde, Rukuba, Jos and Ngell. The gravel of Tilde is fine grained, while that of Jos and Ngell is coarse. The rocks of the Tilde and Rukuba plateaux consist of soft felspathic gneisses, which are often garnetiferous, and are cut by veins of muscovite-pegmatite. Dykes of basalt and dolerite are also of frequent occurrence. The rock composing the plateaux of Jos and Ngell is a reddish biotite-granite, passing into a quartz-porphyry on the margin.

Tinstone has hitherto been found only in the gravels, and its mode of occurrence in the rocks from which it has been derived has not yet been definitely determined. Lumps of tinstone, more or less angular in shape and having a granitic matrix, have been found in the neighbourhood of Jos. This fact has led the engineers who have prospected the country to infer that the tinstone is probably disseminated in the red granites, with lodes in the neighbourhood of the coarse material.

The tinstone is very irregularly distributed in the gravel. Adjoining pits differ considerably in their yield, which varies from 10 lb., or less, up to 400 lb. per ton. The gravels have hitherto been worked principally in the neighbourhood of the river Delime, but they appear to be more or less rich in tinstone over the whole surface of the plateaux.

Metallic tin is frequently found in small quantity in the sands and gravels of the river Delime. It has been described as being native tin of natural origin, but this is probably not the case. Its general appearance, and the fact that it is usually found only in the vicinity of native smelting works, justifies the view that it is of artificial origin. It probably represents material smelted by the natives and subsequently thrown into the gravel with rejected slags.

The "black tin" obtained by washing the gravels is seldom pure tinstone; it usually contains a considerable amount of

impurity such as ilmenite and zircon, and monazite is sometimes present. The following table shows the approximate mineral composition of a fairly typical sample of "black tin" from the Tilde plateau, which has been examined recently at the Imperial Institute (see also this *Bulletin*, 1903, **1**. 21). The separation of the various minerals was made by an electromagnet.

Ilmenite, Garnet	about 20 *per cent.*
Monazite	about 5 *per cent.*
Tinstone with some zircon rutile, quartz	about 74 *per cent.*

A chemical analysis of a Tilde sample gave the following results :—

		Per cent.
Stannic oxide	SnO_2	67·96
Silica	SiO_2	2·94
Thorium oxide	ThO_2	0·20
Titanium dioxide	TiO_2	6·71
Cerium oxide	Ce_2O_3	2·20
Ferric oxide	Fe_2O_3	2·33
Alumina	Al_2O_3	8·07
Lead oxide	PbO	0·60
Ferrous oxide	FeO	5·38
Manganous oxide	MnO	0·47
Lime	CaO	1·10
Magnesia	MgO	0·56
Phosphoric acid	P_2O_5	1·06

Previous to the location of these deposits by the officials of the Niger Company during the latter part of 1902, tinstone had been smelted by the natives, and tin was sold in the local markets in the form of thin rods of very pure metal. Mr. Nicolaus gives the following description of the procedure adopted by the Hausa natives in washing and smelting the tinstone :—

"The washers, usually working in gangs of three or four, wade into the river, tributary, creeks or gullies, generally at or near some shallow rapids, and loosen the gravel under water with a short

hoe-like implement and scoop it into large calabashes about 18 to 24 inches in diameter; as soon as sufficient gravel is collected (about 30 lb.) it is washed and the resulting rough concentrate placed in a smaller calabash, 6 to 8 inches in diameter, and thoroughly cleaned (nearly all the fine tinstone being lost). The resulting 'black tin' containing the equivalent of from 60 to 65 per cent. metal, is sun dried and packed in bags and skins for transport to the smelting furnaces. A gang of four natives will produce on the average in an ordinary day's work 80 lb. to 1 cwt. of clean 'black tin.'

"The 'black tin' is usually smelted in various parcels on a royalty basis exclusively by members of one family, who hold the process a great secret. Only three smelting furnaces are in use, and these are each capable of turning out about 2 cwt. of metal per day. They are built of well-puddled clay, and are 3 feet 6 inches in diameter, and have at the back four tuyere holes conducting the blast from primitive sheepskin bellows to the hearth. The tin is reduced by means of charcoal, and runs through a channel 2 feet 6 inches long and 4 inches broad into a catch pot, whence it is ladled by small gourds or calabashes and poured.

"The tin is cast in the form of thin bars of about one-eighth inch diameter and 12 inches long, which are produced by pouring the molten metal on semicircular banks of clay, 18 inches high, perforated by dry guinea corn halms."

Until recently, prospecting was made practically impossible owing to the hostility of the native tribes, and when in 1902, the Niger Company's engineers visited the tinstone district, they were only able to work under the protection of an escort. Even as recently as 1904, the hostility of the natives of Jos rendered development difficult and the High Commissioner ordered troops to march from Loko (on the Benue) viâ Keffi, in order to open up a direct route to the tin field. The establishment of this route is now in progress, and is described as follows by the High Commissioner in his report for 1905–6:—"The new route to Western Bauchi and the tin mines was opened up during the year. It starts from Loko, on the Benue, which is only 110 miles from Lokoja, and is therefore much more accessible than Ibi (300 miles) or Amar (390 miles), which were the former ports for

the route viâ Wase, viz. 14 days instead of 27. It traverses the Nassarawa province, passing through the head-quarters at Keffi to Darroro; thence it ascends the Assab, Sura or Kibyen plateau. . . . The next step will be to bridge some of the streams or to reconstruct a cart road for at least a part of the distance, and I hope during 1906 to commence this work."

Having held prospecting licences in the Bauchi province for some time, the Niger Company in 1905 applied for mining licences in certain selected areas. In spite of some difficulty due to lack of water supply in the dry season, the company secured an output of one ton per day of "black tin," and thus proved conclusively that the gravels could be worked profitably.

The present head-quarters of the prospecting party are at Jos, where large stores, offices and native houses have been erected. The staff includes four Europeans, and some 200 native labourers are constantly employed at the works. In addition to these, many natives are engaged in the work of transport and gravel-washing. At one period during the latter part of 1906, smelting was carried on day and night in four shifts. The fuel used is entirely wood charcoal, in the making of which many natives are constantly employed.

With tin at its present high price, the alluvial tinstone deposits of Bauchi province promise a fruitful field of work for some time to come, although the absence of transport facilities is a serious drawback. During 1904–5 a preliminary survey of the tin-bearing areas of Bauchi was made by the officers of the Mineral Survey, which is now being conducted in Northern Nigeria in connection with the Imperial Institute. The samples of tin-bearing gravels and tinstone concentrates thus collected have been examined at the Imperial Institute, and the results will probably be published shortly.

It is possible that further tinstone deposits will be found in other districts as the result of the work of the Mineral Survey, which is still in progress. So far only a small portion of the Protectorate has been examined. The geological structure of the country gives every reason to believe that, as the work proceeds, further deposits of commercial importance as a source of tin will be discovered.

GENERAL NOTES.

Annatto Seed from Southern Nigeria.—A sample of annatto seed (*Bixa orellana*) was sent for examination and valuation to the Imperial Institute by the Conservator of Forests for Lagos and Southern Nigeria, with the information that it was obtained from a few plants grown experimentally in the Onitsha Plantations.

The sample weighed about 1 lb., and consisted of clean seeds of good colour and free from any trace of mouldiness. The seeds were classed by brokers as "fair, bright and fresh," and were valued at about 5*d.* per lb.

Recently annatto seed has been scarce in the London market, and as much as 6*d.* and 7*d.* per lb. has been obtained for it, but when normal supplies are available, the price obtainable is from 3*d.* to 4*d.* per lb., though within the last few years it has been sold as low as 1*d.* per lb.

The planting of annatto on a small scale promises under present market conditions to be a profitable enterprise. It is obvious, however, from what has been stated above, that any large increase in the production would diminish considerably the present high price.

Sesamé Seed from Southern Rhodesia.—This sample of sesamé seed, known locally as "Lugonca" or "Ndongca" seed, from Southern Rhodesia, was sent to the Imperial Institute for examination by the British South Africa Company. The seed is said to be cultivated by the natives, who use it in small quantities for food and also anoint their bodies with the oily pulp obtained on pounding the seed.

The sample consisted of 2 oz. of seed, which varied in colour from pale buff to dark brown; it was clean and free from dirt and foreign seeds.

The sample was submitted for valuation to brokers, who stated that it was equal in quality to Coromandel Bigaree Sesamé seed, January crop, the current value of which is £12 7*s.* 6*d.* per ton c.i.f. delivered in London. They added that large quantities of the seed could be disposed of at this price.

Cinnamon Bark from the Gold Coast.—A sample of this bark, prepared from plants grown in the Botanic Gardens at Aburi, was included in a collection of products forwarded recently for examination to the Imperial Institute by the Director of Agriculture in the Gold Coast.

The sample weighed about 1 lb., and consisted of quills of bark rolled upon each other. The quills were not well prepared, as, in some cases, the outer bark had not been carefully and completely removed, whilst in others the quills had been scraped too thin and had become broken in consequence.

The sample was submitted for valuation to two commercial experts, one of whom described the cinnamon as stout and coarse, but of good flavour, and worth about 5*d.* to 6*d.* per lb. in London.

The other firm reported that the cinnamon was not of much value, owing to the unsuitable way in which it had been prepared. The quills were too large and rough and had a mottled appearance, instead of a nice even colour; the flavour and pungency were also not sufficiently strong. They considered, however, that cinnamon of good quality might be obtained from West Africa if more care were taken in the selection and preparation of the bark.

American Tree-Cottons in India.—During recent years considerable attention has been given in India to the perennial or tree-cottons, some of which are known to furnish a product of fine quality. Their occurrence was formerly limited to a few isolated plants in gardens, and the cotton was only used for weaving the sacred thread worn by the high castes. Extensive trials of tree-cottons are now being made by the Indian Long Staple Cotton-Growing Syndicate in Bengal, Assam, and the Central Provinces. Similar work is being carried on at Belgaum with a rough Peruvian tree-cotton. Experiments are also being made in Assam and Behar with "Caravonica" cottons.

A short report on the American tree-cottons in India has been prepared by Mr. C. A. Gammie, Economic Botanist, Bombay, which contains the following particulars.

Several naturalised American cottons have been grown continuously for some years on the Kirkee Farm, Bombay. These plants are provisionally classified as belonging to the Bourbon group, the Peruvian group, and the "chain-seed" group. In the Bourbon group two perennial forms are described which are regarded as derived from *Gossypium hirsutum*, Mill., and *G. barbadense* respectively. In the Peruvian group an account is given of a tree-cotton which, according to the description given in American literature, is not a variety of *G. peruvianum*, but is the perennial form of the Sea Island cotton plant (*G. barbadense*). The "chain-seed" group is represented by a form of *G. acuminatum*, known as Pernambuco, Peruvian or Bahia cotton, which must have been introduced into India at a very early period. Dr. Roxburgh states that this species is a native of the mountains to the north and east of Bengal, but that he did not find it cultivated. It is not grown to any considerable extent, but isolated plants occur in gardens everywhere.

It is considered improbable that the cultivation of American tree-cottons in India will ever become general, since they are more susceptible to climatic changes than the Indian forms. The growth of annual American varieties, however, will probably undergo a gradual extension, but only in those areas which are not well adapted to the indigenous kinds. The cultivation of tree-cottons is attended by the following disadvantages. They give no yield the first year, the risk of failure is carried on from year to year, and, moreover, the prevalence of insect and fungoid pests in India is particularly inimical to the cultivation of perennial forms.

Camphor Oil from German East Africa.—In *Der Pflanzer* for December 1906, an account is given of the results of an examination of camphor oil, obtained by experimental cultivation of the camphor-tree, at the Biological-Agricultural Institute at Amani.

The branches and leaves of the trees were steam-distilled with a view to experimentally preparing camphor and camphor oil from them. After cutting in a machine, these were placed in a steam-distilling apparatus of the ordinary type, and as this is not the best form of apparatus for the purpose, a somewhat small yield of camphor and oil was obtained (under 1 per cent.), but as the plants were only between 1 and $2\frac{1}{2}$ years old, a small yield was to be expected.

Samples of the oil were sent to two German firms, and one of these reported that the oil differs from Japanese camphor oil in containing a remarkably large amount of camphor (between 75 and 80 per cent.), which is much higher than the camphor content of Japanese oil. Another remarkable difference is that the East African oil contains no eugenol and practically no safrol, both of which occur in Japanese camphor oil, but in place of eugenol another phenol, possibly carvacrol, is present.

The Japanese oil is usually freed from camphor before export, so that the two oils are not strictly comparable. The East African oil will be of considerable value as a source of camphor. For further information respecting camphor and camphor oil, and the cultivation of the tree yielding these products, see this *Bulletin* (1905, **3**. 358).

Elemi Resin from Liberia.—A sample of this material, which is occasionally imported into Europe under the name of West African elemi, was received recently at the Imperial Institute. It consisted of an oleo-resin, which possessed a pleasant aromatic odour. It was soft and sticky, though slightly hardened on the exterior, and very dirty, a large quantity of earthy matter, leaves, twigs, and pieces of paper being associated with it. For the purpose of examination, clean pieces of the resin were selected.

The resin dissolves readily in turpentine oil and less readily in alcohol, chloroform or benzene. A chemical examination gave the following results:—The mean acid value is 22·6, the ester value 22·1, and the saponification value 44·7.

On distillation by means of a current of steam, about 11 ccs. of volatile oil were obtained from 100 grams of resin; the specific gravity of this oil, which was dextro-rotatory, was 0·8679.

The principal constituent of the resin is a crystalline substance melting at 167° C. and closely resembling in properties the crystalline substance obtained by More from the oleo-resin of *Dacroydes hexandra* (*Journ. Chem. Soc.*, 1899, 718). Unfortunately no information was supplied with this sample as to its botanical origin, and consequently it is impossible to say whether or not it is yielded by one of the species known to yield the elemi resins of commerce.

These results show that the resin resembles elemi in properties and

composition. It would, however, have little or no commercial value in the dirty condition of the present sample. Good clean soft Manila elemi fetches about £3 per cwt. at the present time. Small quantities of "elemi resins," from other sources than the Philippines, have occasionally been placed on the market in this country, but, owing to their hard and dirty condition, have generally realised low prices (see *Bulletin of the Imperial Institute*, 1904, **2**. 24).

Production of Wattle Bark in Natal and Australia.—Since the introduction of wattles into Natal in 1880, the production of wattle bark in that Colony has shown almost continuous expansion, whereas similar progress has not been made in New South Wales, which is one of the chief centres of production of this material in Australia. During the period 1896–1903, 100,000 tons of the bark were exported from Natal, and in 1904 the amount was 15,819 tons, and in 1905 17,513 tons. In 1906 a slight decrease took place, but this is said to be due to over production in previous years, with the result that a sufficient number of old trees suitable for stripping were not available in 1906, and also in part to transport difficulties during the recent native disturbance in Zululand.

Efforts are now being made in Australia to improve the quality of the bark produced, by selecting only mature trees for stripping, and to modernise the methods of manufacturing wattle bark extract. Attention is also being paid to the possibility of utilising the leaves of the wattles for the manufacture of tanning extract.

Cinchona Cultivation in German East Africa.—In a previous number of this *Bulletin* (1906, **4**. 68), attention was drawn to experiments on the cultivation of cinchona, then in progress, in German East Africa. It is of interest to note that some of the bark has recently been collected in Amani and submitted to chemical examination in Germany.

Two trials were made, the first with bark stripped from branches lopped from the trees, and the other with the bark of stems from trees which had been felled in order to thin out the plantation. In the former case the bark was found to contain 4·6 per cent. and in the latter case 4·84 per cent. of quinine, and 1·93 per cent. of other cinchona alkaloids, in which the absence of cinchonidine was shown. In the stem bark, therefore, the total alkaloid present was 6·77 per cent., a result which is considered very favourable.

The trees which furnished the bark in these tests were hybrids of *Cinchona Ledgeriana* and *Cinchona succirubra*, grown at a height of nearly 3,000 feet; they were raised from Java seed sown nearly four years previously.

Exports of "Henequen" or Sisal Hemp from Yucatan.—About 97 per cent. of the value of the exports from Yucatan, Mexico, is represented by "Henequen" or Sisal Hemp, nearly all of which is sent to the

United States. According to a report of the German consul at Merida, the exports of this product in the year 1905 amounted to 597,289 bales weighing 94,810 tons, and valued at 29,625,430 pesos. The firm prices for "henequen" which prevailed during the year had an important bearing on commercial activity in the State of Yucatan.

The encouragement given by the Government with the view of developing the industries of cattle-rearing, and the cultivation of maize, sugar-cane, tobacco and cotton have had little result up to the present time, as the planters are more and more inclined to devote their energies solely to the production of "henequen," which, their experience shows, yields a greater profit than they can obtain from other crops.

The exports of "henequen" in 1905 were distributed amongst the following countries: United States, 580,411 bales; Cuba, 9,138 bales; Canada, 3,444 bales; Germany, 1,346 bales; United Kingdom, 1,150 bales; France, 1,000 bales; and Belgium 800 bales.

Salt from Turk's Islands.—This sample of salt was brought to this country by the Commissioner of the Turk's Islands. The salt prepared there is said to be in great demand in the United States as a preservative, and the present sample was described as "an exceptionally fine specimen."

It consisted of 1 lb. of salt in colourless crystals of the size used for fish curing. Unlike many salts of commerce, however, there was a complete absence of deliquescence or agglomeration.

The salt has been analysed in the Scientific and Technical Department of the Imperial Institute and the results obtained are given in the following table, which also includes analyses of representative commercial white salts and sea salts for comparison. An analysis by Goessman and Porter of coarse salt from Turk's Islands is also available, and comparison with this shows that the salt produced at the present time is much purer than was formerly the case. None of the recorded analyses of English salt show such a high state of purity as the present sample.

	English.		American.	Sea Salts.		Turk's Islands Salt.	
	Cheshire stoved.	Marshall's.	Anondaya.	St. Ubes, Portugal.	Cadiz.	Analysis previously recorded.	Present sample.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Sodium chloride	98·25	98·40	97·31	96·50	92·11	96·76	99·24
Calcium ,,	0·02	—	0·05	—	—	—	0·22
Magnesium ,,	0·07	—	0·05	0·32	—	0·14	—
Potassium ,,	—	—	—	—	—	—	trace
Sodium sulphate	—	0·11	—	—	—	0·64	—
Calcium ,,	1·55	0·89	1·05	0·88	0·33	1·56	0·02
Magnesium ,,	—	0·03	—	0·25	0·99	—	0·01
Insoluble matter	—	0·05	—	0·10	0·27	—	0·05
Water	—	0·49	1·54	1·95	6·30	0·90	0·10
Iodine and bromine	—	—	—	—	—	—	trace

No borates or nitrates were present in this sample. Its preservative qualities therefore depend entirely upon the sodium chloride present, and the sample is remarkable only in respect of its exceptional purity.

Platinum and Palladium in Brazil.—A survey of the platinum-bearing alluvia in the district of Minas Geraes, Brazil, has been made recently by Dr. Hussak, who has given a summary of his results in the *Zeitschrift für praktische Geologie* (1906, **14**).

An examination of the sands in the region showed that (*a*) magnetite and chromite predominate in the concentrates, (*b*) serpentine fragments occur in the coarser portion, and (*c*) the grains of platinum are rich in iron and strongly attracted by the magnet. It is of interest in this connection to note that the platinum of the Urals is supposed to be derived from an olivine rock rich in chromite. The finer part of the sand contains both platinum and osmiridium, the former in well-formed cubes and the latter in hexagonal plates. A specimen, which under the microscope appeared pure and free from gold, osmiridium and limonite, gave the following results on analysis :—

	Per Cent.
Platinum	82·72
Palladium	0·17
Iridium	1·16
Osmiridium	1·17
Rhodium	1·38
Iron	11·58
Copper	1·77

Three principal localities are described in which platinum sand occurs.

(1) *Rio Abaete, Minas Geraes.*—The characteristics of the platinum-bearing sands of this district are the predominance of magnetite, chromite and perowskite in the fine, heavy sands, and the occurrence of fragments of olivine rock such as lherzolite and picrite among the coarser sands. As a rule the larger grains of metal are much rounded, and well-formed crystals are commoner among the finer material. Diamonds and gold are found associated with it as well as the commoner minerals above mentioned. It appears to be derived from basic eruptive rocks rich in olivine, which are found at the foot of Serra da Matta da Corda, where the Rio Abaete rises. It has therefore a similar origin and composition to that of Nigne Tagilsk in the Urals.

(2) *Condado, Serro, Minas Geraes.*—Both in mode of occurrence and chemical composition the platinum in this district differs greatly from that from Rio Abaete. It does not occur in olivine rocks, but in the primary schist formation consisting of phyllites and quartzites of the Itabirit series. The platinum is found in twisted or screw-shaped grains, which are seldom worn. Diamond, rutile, xenotime and other

minerals are found in association with it. Magnetite and chromite, the characteristic minerals of the previous variety, are almost absent.

(3) *Corrego das Lages, Conceicao, Minas Geraes.*—This platinum-bearing stream flows through the district lying between the towns of Conceicao and Serro. In the Rio St. Antonio valley occur phyllites and schists of the Itabirit series. Overlying these are micaceous quartzites succeeded unconformably by a conglomerate quartzite. The platinum here occurs as at Condado in grains, which are seldom rounded, but more often flattened as the result of earth movements. Crystal inclusions occur in the metal.

The following analyses of platinum grains from these three districts are given:—

	Rio Abaete.*	Condado Serro. 1.	2.	Corrego das Lages. 1.	2.
	Per cent.	*Per cent.*		*Per cent.*	
Platinum	82·81	73·99	72·96	83·38	83·76
Palladium	trace	21·77	21·82	3·03	3·64
Iridium	—	0·08	0·88	1·69	3·61
Osmiridium	—	—	—	1·64	0·70
Iron	9·62	0·10	trace	trace	trace
Copper	trace	—	—	trace	1·12
Quartz and Zircon	—	—	—	2·25	—
Insoluble in aqua regia	7·57	0·92	0·42	—	—
Specific gravity	17·5	16·26	16·36	18·13 to 20·48	

* *This material is strongly magnetic.*

Several other localities where platinum occurs are known, and as might be expected from the character of the rocks there appears to be a wide distribution of the metal. An alloy, which is considered of interest is palladium-gold, which is sometimes found with the platinum and contains 12 per cent. of the former metal. No statistics are given of the commercial importance of the deposits, and it remains to be seen whether they are sufficiently rich to contribute to any extent to the present demand for platinum.

Coals of the United States.—In 1904 the Government of the United States of America voted a subvention of 60,000 dollars to be expended in carrying out a systematic examination of the coals and lignites obtainable from the United States deposits.

The results obtained in the course of these investigations, which were carried out at the Louisiana Purchase Exposition under the supervision of the Director of the Geological Survey of the United States, have been published recently (*Professional Paper No.* 48, *U.S.A. Geol. Survey*). As a result of this policy the nature of the coal resources of the United States is now probably better known than those of any other country. It is impossible in the course of a brief review of this work to do more

than indicate its main features. The collection of the samples was done with the greatest care to obtain specimens for analysis thoroughly representative of the produce of each mine, and in the actual carrying out of the analyses precautions were taken to avoid all known sources of error.

The fuel values of the various materials were determined by the bomb calorimeter method and by means of boiler-tests, and estimation of the amounts of coal gas obtainable from each kind of coal were made in large scale trials worked under industrial conditions. "Coking" tests were made in beehive coking ovens of the standard type and size, and lastly a series of comparative briquetting tests was made, using machinery both of British and American manufacture.

The following is a brief summary of the chief deductions drawn from the results of these elaborate investigations :—

The coals of the United States belong to various geological ages, the most extensive deposits being of the carboniferous, cretaceous and tertiary epochs. Those of the Paleozoic period are either bituminous or anthracitic; the Mesozoic coals may be lignitic, bituminous or anthracitic, and the tertiary formations are principally lignite. Geographically they may be divided into a comparatively few coalfields, viz. Pennsylvania, Northern and Southern Appalachian, Northern Interior, Eastern Interior, Western Interior, South-western Interior, and finally the cretaceous coalfields of the Rocky Mountains, and the tertiary lignites of the Southern States. These deposits have been worked, for the most part, only in the vicinity of large towns. The following table gives some of the results obtained by the analysis of typical coals from these various fields :—

	Moisture.	Volatile matter.	Fixed carbon.	Ash.	Calorific value.	Evaporative power (boiler tests).
Appalachian coalfield.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*	*Average for State.*
Alabama (Carbon Hill) .	2·42	34·83	51·62	11·13	7,053	8·31
West Virginia (Kingmont)	1·40	36·65	55·28	6·67	7,813	} 9·46
West Virginia (Rush Run)	2·10	22·67	71·68	3·55	8,278	
Kentucky (Straight Creek)	2·91	36·01	57·55	3·53	7,957	—
Eastern Interior coalfield.						
Illinois (O'Fallon) . .	11·17	39·31	39·20	10·32	6,235	} 6·70
Illinois (Marion) . . .	7·50	31·68	53·67	7·15	6,881	
Kentucky (Earlington) .	8·49	38·05	46·36	7·10	6,858	7·83
Indiana (Boonville) . .	9·28	39·40	41·98	9·34	6,555	7·35
Western Interior and South-western coalfields.						
Iowa (Laddsdale)	11·35	38·65	39·49	10·51	6,303	6·27
Kansas (West Mineral) .	5·11	32·60	53·39	8·90	7,181	7·87
Missouri (Sprague Mo.) .	4·92	32·28	42·28	14·52	6,653	} 6·70
Missouri (Bevier Mo.) .	14·74	38·53	38·95	7·78	6,214	
Indian Territory (Henryetta)	6·77	36·25	51·30	5·68	—	—

In the following table are given the volume and composition of the gas obtained by distilling some typical kinds of American coals, and the brake horse-power developed by gas-engines in which the gases produced were used :—

Duration of test.	Name of sample.	Cubic feet of standard gas produced (62° F. 14·7 pounds pressure) per pound equivalent of dry coal used by producer plant.	Average composition by volume (*per cent.*).						Equivalent pounds of dry coal used by producer per brake horse-power developed at engine.
			Carbonic acid gas, CO_2.	Oxygen, O_2.	Carbonic oxide, CO.	Hydrogen H_2.	Marsh gas, CH_4.	Nitrogen, N_2.	
Hours.									
43·0	Alabama No. 2 (Carbon Hill)	55·0	8·16	0·10	16·65	7·20	5·64	62·24	1·40
22·67	W. Virginia No. 7 (Sun)	75·3	9·61	0·08	12·75	10·30	6·76	60·48	1·24
30·0	Illinois No. 4 (Troy)	51·4	9·72	0·12	15·12	9·98	6·00	59·06	1·34
13·0	Kansas No. 5 (W. Mineral)	57·2	10·26	0·13	12·40	9·05	7·42	60·73	1·37
22·0	Iowa No. 2 (Hamilton)	51·6	10·06	0·17	12·57	9·53	7·67	60·00	1·47

The Appalachian Coalfields.—The principal mines in these fields are situated in the north, but few of the firms there offered their coals for examination, and the samples examined were chiefly from mines in Pennsylvania, West Virginia and Alabama. The coal is bituminous and several coking tests made on samples from West Virginia gave good results, the coke formed being strong and dense and suitable for metallurgical purposes, though some samples contained large amounts of ash and sulphur, which are objectionable features. Some improvement in these respects was effected by washing the coke, but often the reduction of ash was not more than one per cent.

The coal from the Warrior basin, in Alabama, at the southern extremity of these fields, shows a higher percentage of ash than that from the North and the coke produced is friable.

The Eastern Interior Coalfields.—The principal mines of this field are in Illinois, Kentucky, and Indiana. The coal is not generally of so high a grade as that from the Appalachian region, but its proximity to the great manufacturing centres of Chicago and St. Louis has led to extensive development. Much of the coal contains a large proportion of ash and sulphur, does not coke well or produces a friable material, and is generally unsuitable for use in blast furnaces.

The Western Interior Coalfield.—This covers a very large area in the States of Iowa, Missouri and Kansas. The seams are of irregular thickness and the analyses of the coals show frequently high percentages of ash and sulphur and moisture, rendering them unsuitable for most metallurgical purposes.

The South-western Coalfield extends from the Western Interior through Indian Territory and part of Texas. The ash and sulphur are

lower than those of the Western Interior coals, but the coals are non-coking.

Graphite.—With reference to the articles on graphite which have appeared in the last two numbers of this *Bulletin*, it may be noted that the present classification of the Ceylon graphite is into "Large lump," "Ordinary lump," "Chips," "Dust" and "Flying dust," for which the usual abbreviations are:—L.L., O.L., C., D., and F.D.

An important paper by Mr. A. M. Ferguson on Ceylon graphite published in 1885 in the *Journal of the Ceylon Branch of the Royal Asiatic Society* (Vol. ix., Part ii., p. 171) may also be mentioned.

NOTICES OF RECENT LITERATURE.

NEW BOOKS.

A MANUAL OF FORESTRY. VOL. I. FOREST POLICY IN THE BRITISH EMPIRE. By William Schlich, Ph.D., C.I.E. Third Edition, Revised and Enlarged. Pp. xi. + 246. VOL. IV. FOREST PROTECTION. By W. R. Fisher, M.A. Second Edition. Pp. xxiii. + 712. (London: Bradbury, Agnew & Co., Ltd., 1906.)

Previously published volumes of Dr. Schlich's *Manual of Forestry* dealing respectively with Practical Sylviculture and Forest Management have been reviewed already in this *Bulletin* (1904, **2**. 211, and 1905, **3**. 204). The greater part of Vol. I., now under notice, is concerned with a consideration of the efforts being made at the present time in various parts of the British Empire to administer scientifically the forest resources of the States concerned. The first part of the volume, however, deals with the Utility of Forests. It is pointed out that such utility is both direct and indirect; direct through the actual marketable produce of the forest, and indirect through the influence which forests exercise upon the climate, regulation of moisture, stability of soil, healthiness of the country, and, last but not least, upon the character and physical well-being of the people. Careful consideration will show that these influences may be regarded from two different standpoints, viz., that of the private owner and that of the State. It will be obvious that, as a general rule, the private individual is concerned solely with the direct utility of his woodlands, while the State alone can be expected to be interested in indirect results in addition to direct effects.

These facts have an important bearing upon the question discussed in Part II. of the book, viz., the State in Relation to Forestry. The various reasons for and against the maintenance of State forests are discussed, the author concluding that there is no valid argument against

State forests so long as they yield an adequate income, or successfully serve their purpose as protection forests.

In dealing with the forest policy of the Empire in Part III., precedence is naturally given to a survey of the forest policy of the Government of India. Forest conservancy in India attracted the attention of the Government very early in the nineteenth century, and for fifty years the economic management of the Indian forests, especially the teak forests, was from time to time strongly urged. It was not until 1856, however, that a comprehensive forest policy on the part of the Government was laid down by Lord Dalhousie, and pre-eminent among those who have carried out the work stands the name of the late Sir Dietrich Brandis.

During the last fifty years, practically a quarter of the area of the country has been brought under the control of the Forest Department. The magnitude and importance of the work may be judged from the fact that the average annual revenue from the State forests during recent years has been approximately ten million rupees, and promises to become one of the important items of the balance sheet of the Indian exchequer.

Next to India, Cape Colony has given the most serious attention to scientific forestry, and, in this connection, it is interesting to notice the recent establishment at Tokai, Cape Colony, of the Government South African School of Forestry, where the future officers of the Forest Services of the South African Colonies may gain the whole of their training under local conditions.

Space does not permit of more than a brief reference to the work being done in other parts of the Empire. After referring to the efficient forestry administration in the Straits Settlements, the author proceeds to deal with the general lack of appreciation of the importance of the forestry question in the Australian States, and in Canada where the existing Government control is wholly inadequate considering the magnitude of the interests involved. The resolutions passed at the Canadian Forestry Convention, recently held at Ottawa, however, afford a satisfactory indication that the importance of the forestry question in the Dominion is again being strongly urged upon the Government. There can be little doubt that it is a very unsatisfactory state of affairs that Canada and Australia, the two colonies best capable of providing the Empire with the greater part of its timber of general utility, should be the two most notable examples of neglect, on the part of the State, of the forestry question.

The last chapter deals with forestry in the United Kingdom.

The fourth volume, by Mr. Fisher, is the second edition of an English translation of Dr. Hess' *Forstschutz*, published in 1895. The book, which cannot be adequately dealt with in a brief notice, is not a mere translation, however, for much information has been added which should be of value to the British and Indian forester. The necessity for Forest Protection, from man in his capacity as woodcutter, from fire, atmo-

spheric and other natural phenomena, animals, plants as weeds and parasites, insects and fungi is discussed in detail, and the general methods found by experience to be successful in affording such protection are fully described.

SCIENCE IN SUGAR PRODUCTION: AN INTRODUCTION TO THE METHODS OF CHEMICAL CONTROL. By T. H. P. Heriot. Pp. viii. + 108. (Altrincham: Norman Rodger, 1907.)

This is a reprint of a series of articles entitled "Simple Methods of Chemical Control" contributed by the author to the *International Sugar Journal.*

The articles were written especially for the practical sugar maker who has not had a chemical training, and describe in language as little technical as possible the instruments and methods employed in making the various analyses incidental to the proper control of a sugar factory conducted on modern lines.

A complete scheme of control is outlined and the points at which chemical supervision is more particularly required are indicated. Not the least important feature of the book is the series of suggestions for the construction of the very simple laboratory furniture, which the author considers necessary for his purpose, and the list of apparatus and chemicals given at the end of the volume will doubtless be useful to those undertaking work of this kind for the first time.

Mr. Heriot's book should be of considerable value in many of the British tropical countries where sugar production is carried on under conditions which preclude factory control by a skilled chemist.

LECTURES TO SUGAR PLANTERS: IMPERIAL DEPARTMENT OF AGRICULTURE FOR THE WEST INDIES. Pp. i. + 176 with 65 figures. (London: Dulau & Co., 1906.)

The volume contains a series of seven lectures delivered to sugar planters in Barbados by officers of the Imperial Department of Agriculture some three years ago. Lecture 1 by Sir Daniel Morris, K.C.M.G., &c., the Commissioner of Agriculture, deals with the natural history of the sugar cane in such a manner as to assist especially the younger members of the planting community in understanding the scientific basis of agricultural practice. The anatomy and physiological functions of the various organs of the plant are described and a *résumé* given of the production of seedling canes which are now playing an important part in the West Indies.

Professor J. P. d'Albuquerque devotes lectures 2, 3 and 4 to the consideration of soils and manures in relation to the cultivation of the sugar cane. The origin of soils and their chemical constituents are fully described, followed by an account of the physical properties of the chief constituents, and the history and usefulness of the organisms occurring in the soil. Under the heading of the improvement of soils,

such practical matters as drainage and tillage, the application of farm and artificial manures, and the rotation of crops are dealt with.

In lecture 5, Mr. J. R. Bovell discusses agricultural problems in connection with the planting and cultivation of the sugar cane and intermediate crops, with some suggestions for their solution. The cost of production of a ton of cane is higher in Barbados than in most other cane-growing countries, and the burden of the lecture is that this cost should be lowered by the practice of small economies in the cultivation of the staple and subsidiary crops.

Lecture 6, on the insect pests of the sugar cane and associated crops, by Mr. H. Maxwell-Lefroy gives a useful summary of information and practical remedial methods concerning the principal sugar cane pests, such as the moth borer (*Diatrœa saccharalis*), the weevil borer (*Sphenophorus sericeus*), rootborer and various enemies of the sweet potato, Indian corn and other crops.

The concluding lecture by Mr. A. Howard deals with the fungoid diseases of the sugar cane. They are treated under diseases of (1) cane cuttings, chiefly *Thielaviopsis ethaceticus*, (2) root diseases, *Marasmius*, (3) stem diseases, in which group falls the well-known rind fungus, and (4) diseases of the leaf sheath, the chief being *Cercospora vaginæ*. Practical remedies are suggested for each.

The volume is well illustrated from original drawings and should prove of service not only in the West Indies, but in other countries where the sugar cane is cultivated.

THE COTTON PLANT: ITS DEVELOPMENT AND STRUCTURE AND THE EVOLUTION AND STRUCTURE OF THE COTTON FIBRE. By Abraham Flatters, F.R.M.S. Pp. 112, with numerous plates. (London and Manchester: Sherratt & Hughes, 1907.)

An account is given of the development and structure of the cotton plant, special attention being devoted to the origin and mode of formation of the fibre. The differences in the structure of the principal commercial varieties of cotton are indicated and are illustrated by photomicrographs. The most valuable feature of the work is the excellent series of plates which are employed to demonstrate the morphological and histological structure of the various parts of the plant.

GOVERNMENT HANDBOOK TO THE TRANSVAAL SECTION OF THE SOUTH AFRICAN PRODUCTS EXHIBITION, 1907. Edited by Wm. Macdonald. Pp. i. + 204. (Issued by the Transvaal Department of Agriculture, Pretoria, 1907.)

This handbook, compiled in connection with the South African Products Exhibition held in London during February and March, 1907, was intended to be a guide to the Transvaal section, but the work has been done so completely, that the book forms a valuable handbook to the Colony.

The various chapters on meteorology, climate, geology, agriculture, stock-raising, tobacco, fruit-growing, forestry, etc., have been contributed by the officials of the respective Government Departments in charge of these matters, and may therefore be relied upon to contain an expression of the most recent expert opinion as to the condition and prospects of the various industries. Further, information is given concerning the railways, banking, industries, state of the labour market and rates of wages, and education in the Transvaal. The book is illustrated with many photographs.

"VERB. SAP." ON GOING TO EAST AFRICA. Pp. i. + 107. (London: John Bale, Sons & Danielson, Ltd., 1906.)

This handbook, constituting the second volume of the "Verb. Sap." series, the first of which dealt with the West Coast, contains a large amount of information of value to settlers and sportsmen proceeding to British East Africa. The rapidly increasing popularity of the Protectorate as a country for European settlement has rendered the publication of such a volume a great desideratum, especially to those who, to quote the preface by Lord Hindlip, "cannot number among their acquaintances one who has been to (the) country."

The first few chapters deal in a practical manner with details of outfit, and full information is given as to where the necessary articles may be purchased, either at home or in the Protectorate. The chapter on climate and health should prove one of the most valuable in the book, the advice given being endorsed in a preliminary note by Sir Patrick Manson, K.C.M.G.

An illustrated account of the big-game shooting to be obtained in the country is given in Chapters V. and VI., which contain a large amount of information with regard to the organisation of shooting expeditions. The languages of East Africa are dealt with by Sir Charles Eliot, K.C.M.G., and a useful vocabulary of Swahili words and phrases is appended.

The prospects of the country from the settler's point of view have been dealt with in Chapter IX., which consists of a reprint of the report on "Settlers' Prospects in British East Africa" (Parliamentary Papers, Africa, No. 4, 1905) by Mr. Linton, late Director of Agriculture in the Protectorate.

PRACTICAL COAL-MINING: by Leading experts in Mining and Engineering under the Editorship of W. S. Boulton, B.Sc., F.G.S., Volume I. Pp. vi. + 160. (London: The Gresham Publishing Company, 1907.)

This is the first volume of a comprehensive treatise on coal-mining. The subject is divided into eighteen sections, of which only three and a portion of the fourth are comprised in the present volume, and each section is the work of a specialist in the subject with which it deals.

The first is devoted to the geology of the coal measures and is

undertaken by Professor Boulton himself. It contains an excellent account of the character, flexures and dislocations of stratified rocks, with especial reference to the carboniferous system, which is described in some detail, each coalfield in the British Isles being dealt with in succession. Foreign and colonial coals are, however, only very briefly referred to.

The second section, by Mr. C. A. Seyler, deals in an exhaustive fashion with the analysis and composition of coal. He gives a detailed classification based mainly on the percentages of carbon and hydrogen shown by the ultimate analysis.

In the third section, Mr. H. F. Bulman gives full particulars of the different methods of boring for coal, and the volume concludes with the first instalment of Professor Louis's contribution on shaft-sinking, which promises to be not the least valuable part of the work.

SPECIAL REPORTS BY THE GOVERNMENT GEOLOGIST ON THE OIL-FIELDS OF TRINIDAD. District East of Erin. (Trinidad: Government Printer, 1906.) Council Paper No. 147.

The oil rocks available are (1) the Galeota oil sand on the crest of the Southern anticline near Chagonary Point, and (2) the Rio Blanco oil sand, cropping out on the northern flank of the anticline, rather more than a mile inland. The new Palo Seco Road opens up a promising part of the oilfield, and at the same time affords sections which disclose the geological structure and enables the depths of the oil horizons to be determined.

A large mud-volcano occurs on the crest of the Southern anticline. The outcrop of the Rio Blanco oil sand, on the other hand, is marked by a pitch deposit, covering the bed of a creek for upwards of 200 yards; oil is seen floating upon the water and gas issues slowly in places. It is believed that this oil rock, when pierced at a sufficient depth, will yield a considerable quantity of petroleum. Its distance below the surface is indicated in the map, which accompanies the report and is on a scale of more than 6 inches to the mile, by lines representing depths of 1,000, 1,500, and 2,000 feet below the surface. It is deeper to the northward, but does not fall below 2,500 feet.

The depth of the Galeota oil sand cannot be calculated very accurately, but in the neighbourhood of the mud-volcano it is evidently only a short distance below the surface.

PRELIMINARY REPORT BY GOVERNMENT GEOLOGIST ON THE ISLAND OF TOBAGO. (Trinidad: Government Printer, 1907.) Council Paper No. 9.

In this report, which is accompanied by a geological sketch map, Mr. Cunningham Craig, Government Geologist for Trinidad, gives the results of a brief examination of the island of Tobago.

The greater portion consists of metamorphic rocks, partly of sedimentary and partly of igneous origin. The former consists of schistose

grits, very often felspathic, with talcose and talc-mica schists, resembling some of the strata in the northern range of Trinidad, but the limestone and graphitic schist, which are so common in that range, are unrepresented in Tobago. Quartz veins are rare, and are chiefly small stringers and segregations; no reefs worth testing, with one doubtful exception, were observed, though it is thought possible that a more detailed examination may be rewarded by the discovery of small auriferous reefs. The schists are often decomposed to a considerable depth and form an excellent soil, which should be rich in alkalis, though, perhaps, deficient in lime. It is never too heavy or impervious. More than half the island consists of basic igneous rock, which has suffered extensive sheering, and is provisionally described as an "epidiorite." It decomposes to a great depth, being locally known as "rotten rock," and affords a soil rich in iron, alumina, lime, magnesia, and soda. It is in excellent mechanical condition, being neither too stiff nor too impervious. When undecomposed the "epidiorite" forms valuable "road metal."

The tertiary rocks are confined to the south-western districts where the land has recently risen. They include clay and shell beds, and in one place a basement pebble bed. They show invariably low dips, and appear from the fossils to be of pliocene age at the earliest. They are largely covered by coral limestone of very recent date, which rises in the flat terraces to a considerable height as in Barbados.

An oil rock evidently crops out below sea level near the south-west coast; for fragments of very pure pitch are washed up on the beach from Crown Point to Lowlands. Judging from the horizontal character of the tertiary rocks exposed, it is probable that this rock extends inland under the newer strata, but it is possible that it belongs to an older and unconformable series.

Mr. Craig recommends a few shallow borings to a depth not exceeding 200 feet at points indicated on the map.

TRINIDAD: REPORT OF THE INSPECTOR OF MINES (Mr. John Cadman) for the two years ending 31st August, 1906.

The principal material exploited is the asphalt of the Pitch Lake. Details are given of the extent to which the level of the lake has been lowered in working the deposit, which proves to be more extensive than had been supposed, much of the margin being covered with soil.

Manjak is worked in two mines in the San Fernando district, but great care is required, as inflammable gas is associated with it. The manjak possesses in a strong degree the power of absorbing oxygen. Carbonic oxide, sulphurous anhydride and sulphuretted hydrogen occur in small amounts, which are sufficient to be a source of discomfort to the workmen, if ventilation be neglected.

The tertiary coal at Cunapo was examined and proved to be of fair quality, but irregularly distributed.

Quarries are worked for road metal and limestone, but the methods

hitherto employed have been unscientific and dangerous to the workmen.

The total output of crude asphalt in 1905 amounted to 117,808 tons, valued at the same number of pounds; that of manjak to 1,077 tons, valued at £1,615, while the 37,423 tons of road material and limestone obtained is stated to have been worth £4,000. Only 80 gallons of mineral oil were produced, but a great development is expected in the immediate future.

REPORT ON THE DOMINION GOVERNMENT EXPEDITION TO HUDSON BAY AND THE ARCTIC ISLANDS ON BOARD THE D.G.S. "NEPTUNE," 1903–1904. By A. P. LOW, B.Sc., F.R.G.S., Officer-in-Charge. (Ottawa: Government Printing Bureau, 1906.)

This report contains a narrative of the voyage of the D.G.S. *Neptune* during the seasons 1903–1904 to the northern parts of Hudson Bay, and the north-eastern Arctic Islands. Following this, under their respective headings, are a short historical account of earlier explorations and discoveries in north-eastern Arctic America; a geographical sketch, with summaries of what is at present known of the inhabitants and geology of the unorganised north-eastern territories of the Dominion; short descriptions of the important whaling and sealing industries; and opinions as to the possible navigation of Hudson Strait and Hudson Bay. Leaving Halifax on August 23rd, 1903, the *Neptune* cruised along the shores of Baffin Island, through Hudson Strait, and across Hudson Bay; an interesting description is given of a voyage up Chesterfield Inlet, where the launch used in this trip went aground and was temporarily abandoned, and especially of an attempt with the captain of the *Era* to reach that ship in a whale-boat. In the following summer, formal possession, in the name of King Edward the VII. for the Dominion, was taken of Ellesmere Island. The account of the voyage is concise and instructive, and is followed by a history of the exploration of the American Arctics from the time of Sir Martin Frobisher in 1576 to that of Sverdrup in the *Fram* in 1902. The description of the manners, customs, and moral characteristics of the Eskimos is graphic, and on this point the help of Captain Comer has been sought. A clear account is given of the geology of the countries visited, including a short summary of the economic minerals. "Iron ores have been found on the islands and shores of the eastern side of Hudson Bay, where they cover large areas. On the western shores of the Bay between Chesterfield Inlet and Churchill, extensive deposits of copper-bearing rocks have been located, and there is every prospect of valuable mines being discovered in that region when the ground has been properly prospected. A valuable mica mine is being worked at a profit (at Lake Harbour) on the north shore of Hudson Strait. Iron ores are known along the west side of the Ungava Bay, and the rocks of the southern side of the Strait in many places are favourable to the occurrence of valuable minerals." Mr. Low gives a somewhat

detailed account of the iron ores of the Nastapoka Islands. Of the richest ore, beds several feet in thickness are found, ranging in iron values from 30 to 60 per cent. "Most of these ores, however," he writes, "would require separation from the bands and lenses of jasper before becoming sufficiently rich to be economically treated in the furnace." And again, "the mining of the ores would also be easy and cheap, if advantage were taken of the great water-power of the Nastapoka river, which falls 160 feet into the sea within a few miles of the best ore deposits, and from which electrical power might be generated easily and cheaply."

The object of the chapter on the navigation of Hudson Strait and Hudson Bay, to quote Mr. Low, "is to point out the period of safe navigation, and the advantages and drawbacks of this route to Europe." An excellent map accompanies this volume; the work is typographically attractive, and the photographic illustrations are well chosen.

BURMA: A HANDBOOK OF PRACTICAL INFORMATION. By Sir J. George Scott, K.C.I.E. Pp. x + 520. (London: Alexander Moring, Ltd., 1906.)

The characteristics of the Burmese, their Buddhist temples, the teak forests, the rice and oil industries have supplied the themes of not a few books on Burma within recent years. In most cases the authors have acquired their knowledge while travelling through the country, and their opinions are based upon a passing acquaintance. Sir J. George Scott has had several years' experience of Burma, having held Government appointments in the Shan States and elsewhere. He has previously written on certain aspects of Burma, and has compiled the present volume that may be shortly described as an unofficial gazetter.

Burma, with its numerous races, affords a remarkable ethnological study. The Selungs inhabiting the islands of the Mergui Archipelago are probably the oldest inhabitants; they come at any rate of a different stock from the other races that are classed under the Tibeto-Burman, Siamese-Chinese, and Môn-Hkmêr sub-families. The author enters fully into the consideration of the various races and their relationships, and illustrations are given of the leading types. The particulars of the administration and education are useful and interesting, and the early history of Burma, as also our dealings with different rulers, are reviewed.

Turning to economic details the author has obtained the assistance of special authorities, and articles, condensed in order to meet the limited compass of the book, are furnished by Mr. E. W. Oates on the Fauna, Captain A. T. Gage on the Flora, Mr. C. W. Bruce on the Forests, and Mr. H. J. Richard on Transport. Petroleum, rubies, jade, amber, and salt are the chief mineral products referred to. The cultivation of rice is discussed at some length under agriculture, and the peculiar methods of growing and preparing Burmese tea are described. Fishing is stated to be a prominent industry, ranking only second to that of rice production: in a country where the tenets of the national

religion forbid the taking of life, this is somewhat unexpected, but as the priests do not hesitate to eat salt fish, and as fish forms one of the chief articles of food among the Burmese, the operations of the fisherman are justified. The hunter is not generally absolved, so that for this and other reasons the sportsman will not meet with the same opportunities as in other parts of India. Naturally the author devotes some space to the description of the pagodas, the monasteries and temples, as representing national architecture. Among art industries, carving in wood and ivory, lacquer work prepared with "thitsi" resin, the product of *Melanorrhœa usitata*, and the manufacture of silver vessels are cursorily dealt with. A special article on musical instruments and harmony, accompanied by examples of native melodies, is contributed by Mr. P. A. Mariano.

SOUTHERN RHODESIA. Edited by Fergus W. Ferguson. Pp. 327. (Published in Great Britain by W. H. & L. Collingridge, Aldersgate Street, E.C.)

This well-illustrated book has been written to supply the want of a detailed account of the history, present condition, and future prospects of the important tract of country known as Southern Rhodesia. The interest of this country from the archæological standpoint is well known, and its acquisition by the British South Africa Company is of too recent date to warrant more than passing mention.

One of the most valuable chapters of the book is that dealing with the agricultural possibilities of Rhodesia, a point of view which runs considerable risk of being overlooked in a land generally associated in the public mind with ideas of mineral wealth. The most important cereal crop at the present time is mealies (maize), for which there is a large demand in both the local and more distant South African markets, the latter of which are accessible by railway. Large areas are also put under winter crops of oats, wheat, barley, manna, and hay; in the majority of cases, good crops result.

The cultivation of tobacco has received considerable attention, and bids fair to become an industry of great importance to the country. Much encouragement is given to this industry by the Department of Agriculture, and American experts have expressed very favourable opinions regarding it. The soil has been found suitable for growing light cigarette tobacco, cigar leaf, and heavy smoking tobacco of excellent quality; there is a good market for the product.

Extensive experiments are being carried out with different varieties of cotton, and the results, together with the fact that indigenous cotton grows luxuriantly in many parts of the country, would seem to indicate that, with sufficient labour and transport available, the crop should be a commercial success. Other crops now under trial are coffee, fruit, vegetables, fibres, oil seeds, and rubber.

The pastoral side of the farming industry is scarcely less important than the purely agricultural, the latest official returns showing an

increase of twenty-five per cent. in the numbers of head of stock over those of the previous year. Woolled sheep and angora goats show a marked increase, and large areas in the Melsetter, Umtali, and Inyanga districts have been proved to be eminently adapted for pasturing high-class merinos.

The book concludes with an account of the principal business houses of Rhodesia, and contains much information which is of value to the intending settler, trader, sportsman, and tourist.

INDIAN AND COLONIAL COLLECTIONS.

THE NEW ZEALAND COURT.

THE Colony of New Zealand consists of a group of islands of a total area nearly equal to that of the United Kingdom.

North Island has Kauri pine forests in its northern district, Auckland, where the climate is so warm as to allow lemons, olives and maize to ripen. There are geysers and hot springs to the north of the large lake, Lake Taupo, which is in the centre of the island. West of the lake are volcanic peaks (Ruapehu, 9,008 feet, Mt. Egmont, 8,260 feet) and the rich dairying district of Taranaki. On the east coast near Hawke's Bay there is good pastoral and agricultural land, and similar land occurs in several of the smaller plains and valleys throughout the island. Totara, rimu and other timbers are exported from Wellington, the southern district of the island.

Large areas have been converted into pasture by burning the forest and sowing English grasses. The island is hilly, and 14,000,000 acres are used only for pastoral purposes; but there are also 13,000,000 acres of more level country available for agriculture.

Middle or *South Island* is traversed throughout its entire length by a mountain range, which has at its northern end the coalfields and gold mines of Nelson and Westland. On the west coast the precipitous western side of the Southern Alps, penetrated by the Sounds, rises abruptly from the sea several thousand feet (Mt. Cook, 12,349 feet). East of the peaks and glaciers of the mountain range, steep-sided valleys lead down to deep lakes, and the plains of Canterbury and Otago open out and extend as far as the east coast.

It is estimated that 9,000,000 acres of Middle Island are barren land. The total pastoral area in the island is 13,000,000 acres, much of the forest having been cleared to form pasture. About 15,000,000 acres, chiefly on the eastern side of the island, are sufficiently level to be used agriculturally.

The MAORIS, the native inhabitants of New Zealand, are a branch of the Polynesian race and speak a Polynesian dialect. According to their own legends they arrived in New Zealand about A.D. 1350. They built small thatched huts to inhabit, the chiefs' houses being larger and elaborately decorated. All their implements and weapons were very primitive and made of wood or stone, jade being specially prized for battle-axes. The garments, often of handsome design, worn by both sexes were a short kilt and a kind of mat thrown over the shoulder, these garments being generally woven from Phormium fibre, while the chiefs wore dog-skin mats. The ancient Maoris possessed a taste for decorative art, their most striking artistic works being carved

figure-heads of canoes, palisades, carved panels, doors, and fronts of houses. An article was never ornamented in such a way as to interfere with its primary purpose and free use. A strictly conventional type of ornamentation was retained for each class of article, and every tribe had its own rendering of the type.

The voyage by steamer from Great Britain to New Zealand takes about six weeks.

In 1863 the first railway in New Zealand was opened, viz. a portion of the line between Christchurch city and the port of Lyttelton. There are now over two thousand miles of railway under control of the Government. The Makohine viaduct on the North Island main trunk line from Auckland to Wellington is one of the highest in the world. Between Wellington and Napier there are three miles of railway on the Rimutaka ranges with an average gradient of one in fifteen, worked by the Fell system. Formerly locomotives, carriages and wagons were obtained from the United Kingdom and the United States, but of recent years all equipment has been made in New Zealand. Dining cars are provided on express trains. Refrigerating cars of the most modern type are used in the transportation of frozen meat and dairy produce.

The fine climate, the richness of much of the soil, the high average yield of wheat, and the fact that New Zealand stands first of all the colonies in its sheep bearing capacity, tend to make the colony a promising field for farmers and agriculturists generally, and for all persons who are prepared to work steadily and to rough it a little during their first years as colonists. The country is peculiarly well adapted for small holdings, and for persons with limited capital.

New Zealand is *firstly* a sheep raising, and therefore a wool producing country: it also exports frozen mutton and lamb largely; *secondly*, a cattle raising country, exporting hides and frozen beef; *thirdly*, a butter and cheese producing country, exporting largely to Australia and the United Kingdom; *fourthly*, an agricultural and fruit bearing country, and exports oats and wheat; and *fifthly*, a mineral bearing country, producing gold, coal, etc.

The principal exports are wool, frozen meat, butter, cheese, skins, tallow, phormium fibre, kauri resin, timber, grain, gold, coal.

The nucleus of the collection of products, etc. in the New Zealand Court was brought together by the late Sir Walter Buller, K.C.M.G.

MINERAL PRODUCTS.

GOLD is the chief mineral. The richest goldfields are those of Auckland, Nelson, Westland and Otago, the first and last of these districts being especially rich. Quartz-mining is increasing in importance as compared with alluvial workings, about 50 per cent. of the total yield of gold now coming from quartz mines. A large amount of dredging for gold is done, especially in Otago.

COAL already ranks next to gold. The chief coal mines are those near Westport in Nelson, Greymouth in Westland, and in Otago. New Zealand bituminous coal is considered equal in steam-raising qualities to coal of the same class found in any part of the world. The British Admiralty take regular supplies for the ships on the China station. Coal mining is one of the most promising industries of the Colony.

Specimens exhibited—

1. New Zealand Coal from the Brunner Coal Company's Colliery, Greymouth. Seam 17 feet thick.
2. New Zealand Coal from the Coalbrookdale Colliery, Buller. Seam 19 feet thick.

SILVER is found, often associated with gold, and considerable quantities are exported.

IRON ores occur, but up to the present have not been utilised commercially on a large scale. Granular iron ores or iron sands are abundant on the west coasts of both islands, the beach in places being largely composed of iron sand. Massive iron ores exist in Auckland and Otago. Within five miles of Collingwood coal mine in Nelson are enormous deposits of limonitic iron ores. Spathic ores of great purity have been found in Auckland, Nelson, and Canterbury.

Specimens exhibited—

Massive iron ores, iron sands and iron bars, steel bars and horseshoes made from the ores.

Building Stones.—Abundant supplies of stone suitable for building purposes and "road metal" are found in every part of New Zealand.

BASALTS, locally known as bluestones, are heavy basic igneous rocks, finely grained in texture, and often occur in columnar masses. Many afford durable building material, but they are not extensively used as such on account of their tough and refractory character and the difficulty with which they are dressed. Their hardness, however, renders them particularly suitable for road metal. Basalts are largely developed in North Island; in Middle Island the stone is most plentiful on the eastern seaboard, inexhaustible supplies occurring at Port Chalmers, Otago.

DIORITE. This rock resembles granite in texture, but has a different mineral composition. It is a useful building stone, and is also a valuable material for road-making. Diorite occurs in many parts of New Zealand, chiefly on the west coast of Otago, and on Great Barrier Island, at which localities it can be readily quarried.

SYENITE, a coarsely crystalline, igneous rock, differs from granite chiefly in the absence of quartz. It is hard and tough, and the New Zealand varieties are of a uniform bluish-grey tint. The rock is suitable for kerbing and paving as well as for ornamental and architectural work.

The chief localities for syenite in New Zealand are the Bluff, situated at the extreme south of Middle Island, and the Boulder Bank at Nelson. The rock is also found on Dog and Stewart Islands, and in many places on the west coast.

GRANITE is a coarsely crystalline, igneous rock containing a large proportion of quartz, with mica and hornblende. It occurs as mountain masses at Preservation and Chalky Inlets on the west coast of Middle Island, and as large blocks on Stewart Island and along the whole of the western shores. The latter blocks afford a stone of fine grain, and of a colour rendering it more suitable for architectural work than the varieties obtained from the former localities. A dark-coloured granite obtained from Ruapuke Island, Otago, has been used in Government buildings at Dunedin.

LIMESTONE is the general term for all sedimentary rocks the basis of which is carbonate of lime. Excellent limestones, suitable for building purposes, are found in Middle Island, especially in the Horse Range, in the Malvern Hills, Canterbury, and at Twelve Mile Creek on Lake Wakatipu. A white granular variety, known as Oamaru Stone, occurs over a large area in Middle Island, and is worked in extensive quarries in the Oamaru district of Otago. The principal buildings of Dunedin are built of this stone, which is exported in small quantities to South Africa and Australia. A lithographic limestone is found at Abbey Rocks, Westland, at Oamaru, and in the Chatham Islands. Marble occurs in many localities in Middle Island. A good statuary marble is found among the gneisses and schists of the west coast.

SANDSTONE is a sedimentary rock consisting of particles of quartz united by a natural cementing material such as silica, carbonate of lime, or oxide of iron. Sandstones are abundant throughout New Zealand. A good freestone is obtained from the quarries at Kokonga, Otago.

DOLERITE, a heavy basic igneous rock, is closely allied to basalt, but coarser in grain. It forms a valuable road metal, but, like basalt, is not extensively employed as a building stone. A dolerite breccia occurs at Port Chalmers, Otago.

TRACHYTE is similar in composition to syenite, but has a finer grain, and may be more or less glassy. Many varieties are found in New Zealand, where the stone is much used for kerbing and masonry work. Port Chalmers supplies a fine grey trachyte, and a useful freestone is found at Harbour Cove, Otago, and at Creightonville, Canterbury. The graving-dock at Port Chalmers is built of a trachyte breccia found in the locality.

Specimens exhibited—

1. Bluestone Basalt, Auckland.
2. " " Karaka.
3. " " Oreti.
4. " " Middle Island.

5. Anamesite, Kerby's Quarry, Timaru.
6. Granite, Adele Island.
7. Limestone, Mount Somers.
8. „ Castle Hill.
9. Oamaru Freestone, Totara Quarry.
10. Dolerite, Hoon Hay.
11. „ Breccia, Port Chalmers.

VEGETABLE PRODUCTS.

Pasture Grasses.—New Zealand is a pastoral country, and the acreage under sown grasses is more than ten times as great as the acreage of artificial pasturage in the whole of Australia. The best results are obtained from sown pastures, since the majority of native grasses, although possessing considerable value as fodder, are unable to withstand close feeding, and do not recover from the effects of fire. All the English pasture grasses thrive well in the colony, and attention is paid to the growing of grasses for seed, which is exported, chiefly to the United Kingdom. Seeds for sowing pasture lands are much the same as those used in Great Britain, a common mixture being cocksfoot, rye, timothy and cow grasses, red and white clover, alsike and rape. Pastures are renewed at intervals of from four to eight years, according to the nature of the land.

COCKSFOOT, *Dactylis glomerata*, is a most valuable pasture grass, since it thrives on a very wide range of soil. Large quantities of seed are raised in North Island, in Banks Peninsula, Middle Island, and in many other parts of the colony.

RYEGRASS, *Lolium perenne*. The growing of ryegrass for seed is now an important industry. The seed is of excellent quality, and the demand is usually good.

TALL FESCUE, *Festuca elatior*. This is one of the most valuable grasses for permanent pastures on good land. It is grown in small quantities in North and Middle Islands.

Specimens exhibited—

1. Cocksfoot, *Dactylis glomerata*. Medium quality.
2. Cocksfoot, *Dactylis glomerata*. Fine quality.
3. Ryegrass, *Lolium perenne*.
4. Tall Fescue, *Festuca elatior*.

Grain.—The largest grain-growing areas are in Middle Island, chiefly in Canterbury and Otago. The yield per acre is larger than in any other Australasian colony.

WHEAT. The most important wheat-growing district is Canterbury Plain, but the best quality wheat is raised in the limestone country of Oamaru in North Otago. The varieties sown are Hunter's White, Pearl, Velvet Chaff, and Red and White Tuscan. Average yield 31 bushels per acre.

Specimens exhibited—

Hunter's White, Pearl, Tuscan, Round Berry, Long Berry.

OATS. This crop is raised chiefly in Otago, Canterbury, Southland and Wellington. The usual varieties grown are Winter Dun, Canadian, Sparrowbill and Danish. Average yield 41 bushels per acre.

Specimens exhibited—

Canadian, Sparrowbill and Black Oats.

BARLEY. The best crops are raised in Nelson and Marlborough. Average yield 35 bushels per acre.

MAIZE. This important crop is grown almost entirely in North Island, chiefly in the Auckland district. Average yield 42 bushels per acre.

RYE. Small crops of this cereal are raised in most parts of the colony, the most important district being Otago. Average yield 24 bushels per acre.

Pulse.—Peas and beans are largely grown for pig and horse feed, and also for export, chiefly to the United Kingdom and Australia. The value of the exports for 1902 was over £22,000. The crops are heavy, especially in the Canterbury district, where 60–70 bushels per acre are frequently obtained. Efforts are being made to produce split peas suitable for human food, in the hope of securing a share in the import trade of Great Britain.

Specimens exhibited—

1. Peas—Prussian Blues, Stratagem, Dun, Yorkshire Hero.
2. Beans.

Tobacco. Several attempts have been made to cultivate tobacco in New Zealand, but up to the present the experiments have not been attended with any permanent commercial success.

Specimen exhibited—

New Zealand grown Tobacco, Auckland.

Tanning Materials.

Specimens exhibited—

Various barks.

Phormium Fibre—New Zealand Flax or Hemp—is obtained from the leaves of *Phormium tenax*, a plant belonging to the Lily family and found wild in New Zealand, Chatham Islands and Norfolk Island. The fibre of commerce is mostly derived from wild or semi-wild plants. The Maoris prepare an excellent fibre by hand, but machinery is employed in the mills worked by Europeans. The leaves are first crushed between

rollers, and the soft tissues stripped off by beaters attached to a revolving drum. The fibre is thoroughly washed, bleached by exposure to the sun, and then dressed and straightened. It is subsequently made up into hanks and baled. Phormium fibre is chiefly used for making rope and twine, and is also suitable for the manufacture of coarse textiles and paper. (See also *Bulletin of the Imperial Institute*, 1907, **5**. 36.)

Specimens exhibited—

1. Phormium fibre, Superior, Comb-scutched, from Wairarapa, Wellington.
   Phormium fibre, Superior, Comb-scutched, from Canterbury.
   Phormium fibre, Fine, from Bay of Islands, Auckland.
   Phormium fibre, Fine, from Taranaki.
   Phormium fibre, Fine, from Marlborough.
   Phormium fibre, Good Fair, from Waikato Heads, Auckland.
   Phormium fibre, Good Fair, from Taranaki.
   Phormium fibre, Good Fair, from Manawatu, Wellington.
   Phormium fibre, Fair, from Manawatu, Wellington.
2. Bale of Phormium fibre as prepared for the English market.
3. Rope made of Phormium fibre.
4. Clothing made of Phormium fibre, on figures of Maori man, woman and girl.

Kauri Resin. Kauri or Kowrie resin, or gum as it is often termed, is an exudation from the Kauri pine. (See Kauri Pine under Timbers.) Some resin is obtained in a fresh condition from living trees, but it is less valuable than the "fossil" resin found buried in the soil, not infrequently in places where Kauri pines no longer exist. Kauri diggers, of whom there are about 7,000 in different parts of the forests, in searching for the resin thrust an iron "resin-spear" through the soil until they feel the hard, fossil resin, and this they dig out with a spade. The resin varies greatly in colour from pale yellow to dark brown or almost black. Pieces obtained from swamps are often very dark-coloured. The most important use of Kauri resin is in the preparation of oil varnishes, the clear pale yellow pieces being the most valuable. For this purpose it is more largely used than even Manila, Zanzibar, or Sierra Leone copals. The varnish is prepared by melting the resin and pouring it into hot linseed oil. Kauri represents nearly two-thirds of the total imports of varnish resins into England. The name Kauri gum is misleading, as gums dissolve in water, and if Kauri were a gum it would be useless as an outdoor varnish. Transparent, or semi-transparent, specimens fetch very high prices, and are used as a substitute for amber in making cigar-holders, pipes, etc. Kauri resin is exported chiefly to England and the United States.

Specimens exhibited—

The grades and approximate values (July 1904) of the specimens exhibited are as follows :—Pale Amber, rescraped, £14 per cwt.; Amber, £12; Dark Amber, £10; Good Bright Dark or rescraped Bright Dark, £9; Bush Gum, rescraped, £8; Superior Dark Amber, £7 10*s.*; Brandy Gum, £7 10*s.*; Rescraped Dark, £7; Low grade, rescraped White, £6; Rescraped, rather poor, £5 10*s.*; Inferior Black, £4 15*s.*; Rough Chips from Rescraped White Amber (small pieces broken off superior grades in handling and packing in bags, etc.), £4 10*s.*; Swampy Brown, £4 10*s.*; Tree Gum, £4; Inferior Ordinary, £3 15*s.*; Small Bright Nuts (small pieces picked out of the ground), £3; Amber Seed (obtained in the scraping of superior grades), £3; Swampy Gum (this is in considerable demand for inferior varnishes owing to the high prices of superior grades), £2 5*s.*; Sugary Black, £2.

Timbers.—New Zealand is remarkably rich in forests containing large quantities of excellent timber. It is estimated that the forest lands comprise 20,500,000 acres. The forests are usually of a mixed character, with one or two kinds of trees predominating to a greater or less extent. Trees of the Pine Order, Coniferæ, form a prominent feature and furnish six of New Zealand's best timbers. (See also *Bulletin of the Imperial Institute*, 1904, **2**. 146.)

Specimens of the following woods are exhibited in the Court—

KAURI PINE (*Agathis australis*) is the most valuable timber tree of New Zealand. It occurs only in the northern end of North Island, and is rare at elevations above 1,500 feet. The average height of the tree is from 80 to 100 feet, but exceptionally it reaches 180 feet, and may attain a diameter of 20 feet. Kauri wood is compact, easily worked, and takes a high polish. "Mottled" and "waved" specimens are much in demand for cabinet and ornamental work. A sample examined in the Scientific and Technical Department of the Imperial Institute gave the following results :—Weight per cubic foot, 37 lb.; crushing strength, 2·04 tons per square inch; coefficient of transverse strength, 2·16 tons per square inch; coefficient of elasticity, 469·8 tons per square inch. Kauri timber is largely employed in house building, interior work of churches, for masts, boats, the body-work of wagons, furniture, casks, rims of sieves, etc. It is an excellent wood for the decks of ships, railway brake-blocks and for carriages. Braces, stringers and tie-beams of wharves, made of this wood, are stated to have remained in good order for many years under much traffic, and for bridge-building it has given good results. Wood-paving blocks of Kauri Pine are said to be very durable. The wood is also of service for the manufacture of stethoscopes and other light instruments. The tree yields the well-known Kauri resin.

Specimens exhibited—

1. Kauri Pine, a large plank.
2. Photographs.
    1. Kauri Pine. (The frame of the photograph is made of Rewa-rewa and Pukatea.)
    2. Kauri Pine in the Northern Wairoa forest, girth, 6 feet from ground, 46 feet 6 inches; height to first branch 65 feet. (The frame of the photograph is made of Rewa-rewa.)
3. Parquetry work made of Rewa-rewa and Kauri Pine.
4. Engraving, on Kauri wood.
5. Kauri Pine, Mottled.

RIMU, or "RED PINE" (*Dacrydium cupressinum*), occupies a larger area of forest than any other native timber tree, being especially abundant on the west coast of North Island from the centre southwards, while in Middle Island it is found in all forest land below 1,000 feet. It has a remarkable and characteristic "weeping" habit and varies in height from 40 to 80 feet with a trunk diameter of from 2 to 5 feet. Rimu is the chief timber employed for general building purposes over two-thirds of the Colony, and is also extensively used by cabinetmakers. The keels of ships of considerable tonnage have been made from it, and it has been extensively used for bridge-building and railway sleepers. Although less valuable than Kauri or Totara, Rimu is adapted to a larger number of uses, rendering it the most important commercial timber of the country. Rimu bark is often used by tanners for certain qualities of leather; it imparts a red tint to the skins. The resin from Rimu trees is of value for the manufacture of varnish.

TOTARA PINE (*Podocarpus Totara*) is widely distributed throughout the Colony, but is most abundant in the southern part of North Island. It ranges in height from 60 to 80 feet or even 100 feet; the trunk diameter varies from 2 to 8 feet. The finest specimens are found at elevations below 1,200 feet. Totara timber ranks next to Kauri in value. It is an excellent timber for general building purposes, also for bridges, wharves and railway sleepers. Owing to its power of resisting attacks of the teredo, it is of high value for marine piles, and only excelled for such purposes by the Greenheart of British Guiana. Its chief defect is stated to be its somewhat brittle character. The wood is occasionally handsomely figured and mottled, choice specimens of such being greatly valued for ornamental work. [Specimens of mottled Totara are exhibited in the Court.] The districts around Hawke's Bay supply the largest part of the Totara used. It is exported only to a limited extent.

Specimens exhibited—

1. Totara wood.
2. The frames of some of the photographs are made of Knotted Totara. (See list of Photographs.)

KAHIKATEA, or "WHITE PINE" (*Podocarpus dacrydioides*), forms considerable forests of striking aspect in the swampy country by the Northern Wairoa River, although not always restricted to the low-lying lands. The tree attains a maximum height of 150 feet, but usually ranges from 60 to 100 feet, with trunks from 1 to 5 feet in diameter, free from branches to a great height. White Pine takes a high finish and polishes readily. It is largely employed in New Zealand for interior work in house-building, for ornamental work, such as panels, dadoes, etc., and also for furniture and various other uses. Given sufficiently cheap means of working, it is suggested that Kahikatea timber is specially suitable for conversion into paper pulp. The available supply is stated to be very large.

MATAI, or "BLACK PINE" (*Podocarpus spicata*), is generally distributed throughout New Zealand from sea level to 1,800 feet, and is plentiful in the centre of North Island and the western and south-western parts of Middle Island. It attains a maximum height of 80 feet, but the trunk rarely exceeds 3 feet in diameter. Matai timber has been applied to many uses, such as bridge-building and constructive work generally, railway sleepers, etc., but has a special application as a flooring wood in public buildings on account of its wear-resisting properties and the fine glossy surface which it assumes with age.

KAWAKA (*Libocedrus Doniana*), also called "Cedar," is restricted to the northern part of North Island, extending southward only as far as Mount Egmont, and is an erect-growing handsome tree, with a feathery drooping appearance due to an abundance of slender flattened branchlets. The tree sometimes attains a height of 100 feet, and a diameter of 5 feet, and is locally distinguished from other Conifers by the fact that the old bark falls away from the bare trunk in long narrow ribbons. The wood is of dark red colour with dark streaks, and is often of great beauty. It is straight and even in grain, strong, durable, and can be easily split into very thin sections. It is highly valued for cabinetmaking and ornamental work generally. The wood is being experimented with in England as a pencil cedar.

REWA-REWA, or HONEYSUCKLE (*Knightia excelsa*), is a fine tree, 70 to 100 feet high, with a trunk 1½ to 3 feet in diameter. Its lofty stature and slender, poplar-like habit render it one of the most striking forest trees in New Zealand. The wood is usually of a deep red colour, but considerable variation occurs; the grain is straight and beautifully mottled. Rewa-rewa is highly valued for inlaid work, cabinetmaking, interior work in buildings and ornamental turnery. The wood is of great strength but lacking in durability when exposed to the weather. It burns with difficulty and might prove of value for special purposes in which it is desirable to minimise the risk of fire. The local name, "Honeysuckle," is given on account of a fancied resemblance of the flowers to those of the common European climber.

[*Continued on p.* 216.

NEW ZEALAND TIMBERS.

Information supplied by the Department of Industries and Commerce, N.Z.

NOTE.—The Timbers are numbered approximately in the order of importance which they occupy in the timber trade, which order is gauged by the sizes and quantities of the timbers available and their comparative usefulness. Most of these timbers are represented in the New Zealand Court at the Imperial Institute.

Number.	Botanical Name of Timber.	Native Name of Timber.	Description of Timber.	Where Obtainable.	Sizes Procurable.	Uses of Timber.	Approximate Price F.O.B. per 100 Superficial Feet 1 in. thick.
1	*Agathis australis*	Kauri	Yellowish-white, sometimes light-brown, and sometimes mottled; straight in grain, strong and elastic, of a silky texture, and durable	Throughout the northern portion of North Island	Long lengths, and up to great widths	General building purposes, joinery and cabinetmaking, bridge and wharf work, spars, etc. Second-class timber used for packing-cases, etc.	16*s.* for long lengths
2	*Dacrydium cupressinum*	Rimu, commonly called red-pine	Deep-red in colour, with dark or light streakings, forming handsome markings; strong and durable	Throughout the colony	Long lengths, and up to 24 in. in width	General building purposes, joinery and cabinetmaking	8*s.* 6*d.* all heart
3	*Podocarpus Totara*	Totara	Deep-red in colour, clean and straight in grain, compact, and durable both in and out of the ground; also capable of resisting the marine worm for protracted periods	Throughout the colony	Long lengths, and up to great widths	General building purposes, joinery and cabinetmaking, bridge and wharf work, and wood pavements	15*s.* all heart; 13*s.* first-class building timber
4	*Podocarpus dacrydioides*	Kahikatea, commonly called white-pine	White, sometimes pale-yellow; firm and tough, straight in grain, even in texture, and very light	Throughout the colony	Long lengths, and up to great widths	White-wood furniture, packing-cases, butter-boxes, tallow-casks, and coopers' ware, covering-boards for boats	6*s.* 6*d.*
5	*Podocarpus spicata*	Matai, commonly called black-pine	From light to deep brown in colour, very smooth and even in texture, strong and durable	Throughout the colony	Long lengths, and up to 24 in. in width	General building purposes, especially lining and weather-boarding, joinery and cabinetmaking	10*s.* all heart
6	*Dacrydium westlandicum*	Commonly called silver-pine	Yellowish-white in colour, sometimes mottled; straight and even in grain, dense, firm, and compact, of great strength and toughness	Principally on the west coast of the South Island	Up to 20 ft. long and 15 in. in width	Bridges, wharves, sleepers, mining timbers, cabinetmaking; also in building and joinery generally	16*s.*
7	*Fagus fusca*	Tawhai, commonly called black-beech	Red in colour, straight, even, compact in grain, tough, and durable in all situations	Throughout the colony	Long lengths, and up to 24 in. in width	Railway sleepers, piles, stringers, bridge and wharf planking, and mining timbers	11*s.*
8	*Metrosideros tomentosa*	Pohutukawa	Deep-red in colour, heavy and compact, and of great strength; exhibits great power of resistance to the teredo	North Island	Short lengths, and up to 24 in. in width	Ships' timbers, framing and sills of dock-gates	12*s.*
9	*Knightia excelsa*	Rewa-rewa, commonly called honeysuckle	Deep-red in colour, and beautifully mottled in silver grain	Throughout the North Island and northern portion of South Island	Lengths of 20 ft., and up to 24 in. in width	Ornamental cabinet-work generally	15*s.*
10	*Vitex littoralis*	Puriri	Dark-brown in colour, excessively hard, dense, and heavy, of great strength and durability	Throughout the northern half of the North Island	Up to 20 ft. in length and 15 in. in width	House blocks, piles, railway sleepers, machine beds, and for ornamental cabinetmaking	20*s.*
11	*Olea Cunninghamii*	Maire	Deep-brown in colour, often streaked with black, and highly ornamental; durable, even in grain, and takes a good finish	Throughout the North Island	Up to 20 ft. in length and 20 in. in width	Framing for machinery, millwrights' work, and ornamental cabinet-work of all descriptions	15*s.*

12	*Metrosideros robusta*	Rata	Red colour, straight in grain, hard, dense, heavy, of great strength and durability	Throughout the colony	Long lengths, and up to 48 in. in width	Wheelwrights' stuff, framework of railway wagons and carriages; also for machine beds and bearings	14*s.*
13	*Podocarpus ferruginea*	Miro	Brown, with darker heart; straight and even grain, hard, elastic, and of great strength	Throughout the colony	Long lengths, and up to 24 in. in width	Cabinetmaking and turnery; marine piles	14*s.*
14	*Libocedrus doniana*	Kawaka, commonly called New Zealand cedar	Deep-red in colour, with dark streaks	Throughout the colony	Long lengths, and up to 18 in. in width	Furniture and cabinetmaking generally	16*s.*
15	*Leptospermum ericoides*	Manuka, commonly called tea-tree	Red in colour, dense, straight-grained, and elastic	Throughout the colony	Short lengths only, and small in size	Wheelwrights' work, inlaying, etc.	14*s.*
16	*Fuchsia excorticata*	Kohutuhutu, commonly called fuchsia	Deep-brown in colour, with broad streaks of a paler shade, and narrow black markings; hard and durable	Throughout the colony	Short lengths only, and small in size	Ornamental cabinet-work, fencing posts, and house blocks, etc.	15*s.*
17	*Coprosma linariifolia*	Karamu, commonly called yellow-wood	Deep-yellow in colour, smooth, even, and compact	Throughout the colony	Short lengths only, and small in size	Cabinetmaking, inlaying, and other ornamental purposes	18*s.*
18	*Elæocarpus dentatus*	Hinau	Light dull-brown colour, heart-wood darker; tough, strong, and durable	Principally in North Island	Lengths of 20 ft., and up to 24 in. in width	Fencing posts, bridges, and culverts	17*s.*
19	*Alectryon excelsum*	Titoki	Light-red colour, straight-grained, of great strength, toughness, and elasticity	North Island and northern part of South Island	Long lengths, and up to 24 in. in width	Wheelwrights' and coachbuilders' ware, axe handles, swingle trees, and handles of carpenters' tools	18*s.*
20	*Olearia avicenniæfolia*	Akeake	Yellowish, with satiny lustre, frequently wavy, and prettily figured	South Island	Short lengths, and small in size	Ornamental cabinetmakers' work, inlaying, etc.	100*s.*
21	*Laurelia novæ-zelandiæ*	Pukatea	Pale-brown colour, streaked with deeper shades; often very ornamental	North Island and northern portion of South Island	Long lengths, and up to 48 in. in width	Excellent for furniture, and also for boat-building	12*s.*
22	*Weinmannia racemosa*	Towai	Deep-red colour, hard and strong, ornamental grain	Throughout the colony	Long lengths, and up to 24 in. wide	Cabinetmaking and ornamental work	15*s.*
23	*Sophora tetraptera*	Kowhai	Pale-brown colour, compact, heavy, of great strength, toughness, and elasticity	Throughout the colony	Short lengths, and up to 12 in. in width	Bearings for shafts and machinery, swingle trees, teeth and bows of hay rakes, cabinet-work	20*s.*
24	*Pittosporum eugenioides*	Tarata	White in colour, tough, elastic, and of considerable strength	Throughout the colony	Long lengths, and up to 24 in. in width	Turnery, and handles of tools	50*s.*
25	*Dracophyllum latifolium*	Neinei	Light reddish-brown in colour, very prettily figured; takes a high finish, and is of great durability	North of both Islands	Short lengths, and in small sizes	All kinds of ornamental work	20*s.*
26	*Libocedrus Bidwillii*	Pahautea	Red colour, remarkably straight in grain. It is of great durability in all kinds of situations	Throughout the colony	Lengths up to 30 ft., and up to 24 in. wide	Bridge-building, telegraph posts, railway sleepers, fencing posts and rails	20*s.*
27	*Litsea calicaris*	Mangeao	White, firm, strong, and of great elasticity, and is suitable for a great variety of purposes requiring strength, toughness, and elasticity with light weight	North of North Island	Lengths up to 25 ft., and up to 18 in. wide	Ships' blocks, coopers' ware, wheelwrights' bent stuff	20*s.*
28	*Beilschmiedia tarairi*	Taraire	Reddish-brown colour, remarkably straight in the grain, close, but rather brittle	North of North Island	Long lengths, and up to 18 in. in width	Ships' blocks, and for cheap furniture	18*s.*
29	*Pseudopanax crassifolium*	Horoeka, commonly called lance-wood	Lightish-brown, sometimes of a satiny lustre; dense, even, and compact	North Island	Short lengths, and up to 9 in. wide	Wheelwrights' work	20*s.*

Specimens exhibited —

1. Rewa-rewa wood.
2. Parquetry-work made of Rewa-rewa and Kauri pine.
3. The frames of several of the photographs show the ornamental character of Rewa-rewa wood. (See list of Photographs.)

PURIRI, OR NEW ZEALAND TEAK (*Vitex littoralis*), is restricted to the northern portion of North Island, and is a tree 40 to 60 feet high, with a trunk 2 to 5 feet in diameter. It is the strongest of all native timbers, and is most useful where great strength and durability are required. The supply of Puriri has been exhausted in some districts where at one time it was plentiful, and it is now becoming rare.

MAIRE-RAU-NUI, OR "BLACK MAIRE" (*Olea Cunninghamii*), ranks next to Puriri in strength, and, like it, is restricted to North Island. It is an evergreen tree, frequently 70 feet high, with a trunk 3 to 6 feet in diameter. Black Maire is used for cabinetmaking, bridges, wharves, railway carriage and wagon building, and to carry metal bearings in machinery. Like the olive wood of Europe (to which it is related), Black Maire is specially suitable for making ornamental articles.

NORTHERN RATA (*Metrosideros robusta*) is one of New Zealand's largest trees, and, when in flower, its conspicuous scarlet blossoms render it a remarkable feature of the forests. The trees commonly attain a height of from 60 to 80 feet, with a trunk diameter of from 3 to 12 feet. In common with some other trees it possesses the peculiarity of beginning life as an epiphyte. Rata seeds vegetate in the débris which accumulates in the forks of large trees. When the young Rata plants have absorbed all the nutriment available, they send forth roots which travel along the trunk till they reach the soil: the Rata then grows rapidly and finally crushes to death in its growth the host tree on which it was reared. Its large, crooked limbs and root stems are often used for ships' timbers. It is the chief wood used for the arms of telegraph posts, is excellent for railway carriage and wagon frames, and is also valuable for wheelwright's work, bridge-building, etc.

Specimens exhibited (*in addition to those enumerated above*) —

1. Westland Pine or Silver Pine (*Dacrydium westlandicum*).
2. Westland Pine or Silver Pine (*Dacrydium westlandicum*), Mottled.
3. Black Manuka (*Leptospermum scoparium*).
4. Mangeao (*Tetranthera calicaris*).
5. White Maire (*Olea lanceolata*).
6. Titoki (*Alectryon excelsum*).
7. Kowhai (*Sophora tetraptera*).
8. Black Beech (*Fagus fusca*).
9. Akeake (*Olearia avicenniæfolia*).
10. Hinau (*Elæocarpus dentatus*).

ANIMAL PRODUCTS.

Wool is the principal export of New Zealand. Sheep were first introduced into the Colony in 1814. The country is admirably adapted to all classes of sheep. The districts notable for sheep-raising are Hawke's Bay, Wellington, Canterbury, Otago, Marlborough and Auckland. There has been a tendency of late towards the multiplication of smaller flocks (under 500 head of sheep) in place of the few very large flocks of former years. The Merino thrives from the wild mountain-lands near the snow line down to the drier portions of the plains. The Lincoln and Romney Marsh sheep flourish on moist soils; while the finer English and Border Leicesters and Downs do well on the drier lands. The Merino Ewe furnishes the foundation for all the cross-bred varieties, now much in favour both for wool and meat. Shearing commences in September and is continued till January. The staple of New Zealand wool, especially of Longwool and Cross-bred sheep, is remarkably free from breaks and other imperfections incidental to wool from countries subject to long droughts and scarcity of food. The output of New Zealand Wool has become very large. The greater part of the wool exported comes to the United Kingdom. (See also *Bulletin of the Imperial Institute*, 1905, **3**. 6.)

Specimens exhibited—

1. Sample Fleeces of Wool.
    1. Half-bred ewe (Merino ewe—Leicester ram), weight of fleece $5\frac{1}{2}$ lb. Waikato.
    2. Merino ewe, weight of fleece 13 lb. Otekaike Station, Oamaru.
    3. Merino ram, weight of fleece 19 lb. Puketoi.
    4. Half-bred (Merino ewe—Longwool ram), weight of fleece $4\frac{3}{4}$ lb. Marlborough.
    5. Half-bred hoggett (Merino ewe—Longwool ram), weight of fleece $6\frac{3}{4}$ lb. St. Leonards, Canterbury.
    6. Hampshire Down ram, weight of fleece $11\frac{1}{4}$ lb. Ashburton.
    7. South Down ram, weight of fleece 6 lb. Spreydon, Christchurch, Canterbury.
    8. Shropshire Down ewe, weight of fleece $9\frac{1}{4}$ lb. Maraewhenna, Otago.
    9. Romney Marsh hoggett. Waikato.
    10. Lincoln ewe, weight of fleece $18\frac{3}{4}$lb. Keirunga, Oamaru.
    11. Leicester ram, weight of fleece $8\frac{3}{4}$ lb. Inglewood, Canterbury.
2. Bradford Tops, of New Zealand wool.
3. Patterns of Cloth manufactured by the Kaiapoi Woollen Co.

Frozen Meat. The first shipment of frozen meat from New Zealand

was made in 1882. The trade has grown rapidly and now forms one of the largest industries of the Colony. Mutton and lamb constitute about 80 per cent. of the meat exported, the remainder being beef, rabbits, meat extracts, bacon and ham. Sheep bred from Merino ewes and Longwool rams, or from cross-bred ewes with Down rams, are the most suitable for the frozen meat trade, and are known as "freezers." Southdowns and English Leicesters are much in request for producing early maturing lambs, particularly in Middle Island, where the "prime Canterbury" mutton is raised. The principal establishments connected with the frozen meat trade are at Hawke's Bay, Wellington, Canterbury and Otago. Lyttelton is the leading port of shipment for frozen meat, and Wellington, Napier and Timaru are next in importance. Quite three-fourths of the frozen and other meat shipped from New Zealand is sent direct to the United Kingdom, the port of London receiving the largest amount. (See also *Bulletin of the Imperial Institute*, 1905, **3**. 7.)

Preserved Meat. The preserving of meat (canning) is carried on as a collateral industry at most of the freezing works.

Specimens exhibited—

(1) Spiced, Roast and Boiled Mutton; Corned, Spiced, Roast and Boiled Beef; Ox-Tongues, Mince Meat, Soups: The Gear Meat Preserving and Freezing Company, Ltd., Wellington, New Zealand. (2) Pork Sausages and Pure Lard: Christchurch Meat Company, Ltd., Christchurch, New Zealand. (3) Table showing quantities of Frozen Beef, Lamb, and Mutton imported monthly into the United Kingdom during 1906. Diagram taken from Messrs. W. Weddel and Co's. *Review of the Frozen Meat Trade.*

Trout. The rivers of New Zealand contained no trout until trout fry and ova were brought into the country from Scotland and California, about the year 1871, and placed in fish-hatcheries. In one year a single hatchery distributed 671,490 brown trout, 72,000 rainbow, and 2,500 Scotch burn trout. Large numbers of young fish have been set free and, as a result, excellent sport is now to be had in thousands of miles of rivers and streams teeming with trout, and New Zealand has become a paradise for trout-fishermen. The eastern rivers in North Island are fished first, and later in the year the rivers of Middle Island. By moving from north to south it is possible to get sport throughout the season. Rainbow trout thrive well in the rivers of North Island, the temperature of the water being higher than in the snow-fed rivers of Middle Island. In the large lakes trout have been caught weighing more than 30 lb. (See also *Bulletin of the Imperial Institute*, 1905, **3**. 8.)

Specimens exhibited—

1. Trout.
2. Photographs.
    1. Trout, from Wainuiomata, Wellington.
    2. Rainbow Trout, from Lake Waikaremoana, Hawke's Bay.

MISCELLANEOUS EXHIBITS.

1. Figures of Maori Man, Woman and Girl in native clothing made of feathers, Phormium leaf and Phormium fibre. Two carved Model Canoes, Paddles, Weapons and Walking-sticks.
2. Maori carvings.
    1. Carved portions of fronts of Maori Huts.
    2. Tomb Effigies.
3. Parquetry work made of Rewa-rewa and Kauri Pine.
4. Skeleton of Moa, *Dinornis robustus*, lent by Sir Walter Buller.
5. Left leg and foot of largest known example of Moa, *Dinornis maximus*.
6. Paintings.
    1. Huka Falls, North Island, oil painting by Blomfield, N.Z.
    2. A series of water-colour paintings of the scenery of Middle Island, painted and presented by S. H. Moreton, Esq., Christchurch, N.Z.
        1. Mount Cook and Franz Josef Glacier from Okarito, Westland.
        2. Entrance to the Otira Gorge, West Coast Road, Westland.
        3. Mount Earnslaw from Pig Island, Wakatipu.
        4. Pinnacle Rocks from the Landslide, Clinton Basin, Te-Anau.
        5. Black Cone and Mount Anau from the Clinton River, Lake Te-Anau.
        6. Mana-Wai-Pouri from View Hill.
        7. Pembroke Peak and Glacier and Lion Mountain, Milford Sound.
        8. Moffatt Mountain from Gunn's Lake.
7. Photographs.
    1. Hira Hikanui.
    2. Maori Woman.
    3. Maori Food House.
    4. Maori Monument to Her Late Majesty Queen Victoria.
    5. Maoris in the Urewera country.
    6. Wanganui River.
    7. Hongi's Track, Lake Rotoiti.
    8. Paronui-Pa, Wanganui River.
    9. Jerusalem, Wanganui River.

10. Waimangu Geyser, near Rotorua.
11. The Crater, Waimangu Geyser; area of water 400 × 240 ft.
12. "Frying Pan" Flat, Waimangu.
13. Mount Ngaruhoe.
14. Red Deer shot in New Zealand.
15. Red Deer shot in New Zealand.
16. The Southern Alps, Otago. (The outer part of the frame of the photograph is made of Rewa-rewa.)
17. Mount Cook (12,349 feet) from the Hooker River. (The frame of the photograph is made of Rewa-rewa and Pukatea.)
18. The Remarkables, Lake Wakatipu. (The frame of the photograph is made of Rewa-rewa and Totara.)
19. Queenstown, Lake Wakatipu. (The frame of the photograph is made of Rewa-rewa.)
20. The Cathedral Peaks, Lake Manapouri. (The frame of the photograph is made of Rewa-rewa and Totara.)
21. Eighty-acre paddock of Wheat, yield 27 bushels per acre. Springston, Canterbury.
22. Paddock of purple tuscan Wheat, yield 72 bushels per acre. River Styx, Canterbury.
23. Threshing Wheat, Coldstream, Rangiora, Canterbury.
24. Threshing, Rangiora, Canterbury.
25. Freight Locomotive for heavy grade traffic, manufactured in the Colony. (The inner part of the frame of the photograph is made of Rewa-rewa.)

8. Maps.
   1. Map of North Island.
   2. Map of Middle (South) Island.

ROYAL PRESENTS AND ADDRESSES.

Presented to Her Late Majesty Queen Victoria on the occasions of the Jubilee of Her Reign in 1887 *and* 1897.

LENT BY HIS MAJESTY THE KING.

An Address in inlaid wood covers with jade, gold and silver ornaments. From the People of New Zealand.

An Address and signatures in an album with covers of inlaid New Zealand woods.

From the Scholars of the Public Schools in the Educational Division of Auckland.

An Address, and Photographs, in a casket of Colonial woods.
From the Mayor, Councillors and Citizens of Dunedin.

A casket of New Zealand woods to contain "The Art Album of New Zealand Flora."
Casket from the Mayor of Gisborne.
Album from Mr. and Mrs. E. H. Featon.

Framed Addresses from—

The Legislative Council and House of Representatives of New Zealand.
The Mayor and Corporation of Christchurch.
The New Zealand Veterans' Association, Wellington.

Addresses from—

The University of New Zealand.
The Mayor, Councillors and Burgesses of Invercargill.
The Women's Social and Political League, Wellington and Christchurch.

Presented to Their Royal Highnesses the Prince and Princess of Wales during the "Ophir" Tour, 1901. *Lent by Their Royal Highnesses.*

A book containing specimens of New Zealand ferns with covers of marqueterie, in a casket of indigenous woods.
From the Government of New Zealand.

Three Jade Meres.
Jade adze-blade.
Jade ear-ornament.
Jade tiki.
Whale's-bone Mere.
„ „ Kotiate.
„ „ Waha-ika.
Wooden Hani.
„ Tewha-tewha.
„ Carved staff.
Phormium and feather cloaks.
Dyed phormium belts.
Plaited fibre waistcoats.
„ tie.
Framed Address.
From the Maoris of New Zealand.

Model of Maori house of carved wood with jade, gold and silver ornaments.
From the Counties of Otago and Southland.

Carved wood Huia box with Huia feathers.
From Lady Ranfurly.

Carved wood Huia box to contain trowel and mallet (not shown), used in laying the foundation-stone of the Railway Department Offices of New Zealand.

An Address in a casket of polished woods with silver ornaments.
From the Citizens of Christchurch and District.

An Address and Album of Views in marqueterie wood covers.
From the Cornish Society of New Zealand.

An Album of photographs in marqueterie wood covers.
From the Ladies of Tauranga.

An Address in wood covers.
From the Jewish Communities of New Zealand.

An Address in a silver cover with jade corners and an oval panel of marqueterie in centre.
From the Citizens of Auckland.

An Address with carved inlaid wood covers.
From the Scottish Societies of Dunedin.

An Address in a cylindrical wood case with silver ornaments.
From the Loyal Subjects in Greymouth and Grey District.

An Address on silver rollers.
From the Citizens of Dunedin.

Framed Addresses from—

The People of New Zealand.
The Women of New Zealand.
The Yorkshire Society of New Zealand.
The Hawke's Bay Highland Society.
The Wellington Harbour Board.

Addresses from—

The Maoris of South Island.
The New Zealand Section of the Wesleyan Methodist Church of Australasia.
The Town and District of Port Chalmers.
The Chinese Residents of Wellington.
The Mayor and Councillors of Palmerston.
The Auckland Harbour Board.
The Presbytery of Auckland.
The Baptist Union of New Zealand.
The Pioneer Settlers of Wellington.
The Presbyterian Church of Otago and Southland.
The New Zealand Branch of the British Medical Association.
The Yorkshire Society of Auckland.
The Wellington District Law Society.
The Grand Orange Lodge of New Zealand.
The Municipal Association of New Zealand.
The Freemasons of New Zealand.
The Various Friendly Societies of Otago.

Presented to His Majesty the King on the occasion of His Coronation, 1902.
LENT BY HIS MAJESTY THE KING.

An Address bound with photographs in an inlaid wood case with gold and jade enrichments.
From the Electors of Westland.

A Framed Address.
From the Premier and Members of the Ministry of New Zealand.

A Model of a Maori House of wood with jade supports.

LIBRARY.—RECENT ADDITIONS.

Books, etc., exclusive of Government Publications, presented to the Library since March 18th, 1907.

Report of the Ceylon Chamber of Commerce for the half year ended 31st December, 1906	(*The Secretary.*)
A Fruit-grower's Handbook of the Culture and Management of Fruit Trees . .	By Claude Fuller. (*The Times Printing and Publishing Company, Limited.*)
Walch's Tasmanian Almanac for 1907 .	(*The Publishers.*)
Sand's Sydney, Suburban and Country Commercial Directory for 1907 . .	(*The Publisher.*)
The Gold Fields of South Africa . .	By J. Howard Reed, F.R.G.S. (*Imperial South African Association.*)
Nouvelles Archives des Missions Scientifiques et Litteraires, Tome xiii. Fasc. 4.	(*Imprimerie Nationale, Paris.*)
Jahresbericht der Deutschen Gerberschule zu Freiberg im Sachsen, No. 18 . .	(*The Director.*)
The Stock Exchange Official Intelligence for 1907	(*The Stock Exchange.*)
The University of Leeds: Third Report, 1905–1906	(*The Registrar.*)
The Directory of Paper Makers for 1907 .	(*Messrs. Marchant Singer & Co.*)
The Fauna of British India, including Burma and Ceylon. Butterflies, Vol. ii.	By Lieut.-Colonel C. T. Bingham. (*Secretary of State for India.*)

The Chronicle and Directory for China, Japan, Straits Settlements, Malay States, etc., for the year 1907 . . .	(*"Hong Kong Daily Press."*)
Lectures to Sugar Planters . . .	(*Imperial Department of Agriculture for the West Indies.*)
Southern Rhodesia: an account of its past history, present development, natural riches, and future prospects. With special particulars for intending settlers, numerous illustrations, and much general information . . .	Edited by Fergus W. Ferguson. (*Messrs. W. H. & L. Collingridge.*)
Hamburg's Handel im Jahre 1906 . .	(*Handelskammer Hamburg.*)
The Journal of the Royal Agricultural Society of England, Vol. lxvii., 1906 .	(*The Secretary.*)
Report of the Burma Chamber of Commerce for the year 1906 . . .	(*The Secretary.*)
Schlich's Manual of Forestry. Vol. i. Forest Policy in the British Empire .	By W. Schlich, Ph.D., C.I.E., F.R.S., F.L.S., M.A. Oxon. (*Messrs. Bradbury, Agnew & Co.*)
Practical Coal-mining, Vol. i. . . .	Edited by W. S. Boulton, B.Sc., F.G.S. (*The Gresham Publishing Co.*)
Science in Sugar Production; and introduction to the methods of chemical control	By T. H. P. Heriot. (*Mr. Norman Rodger.*)
The Egypt of the Future . . .	By Edward Dicey, C.B. (*Mr. William Heinemann.*)
The Cotton Plant: its development and structure and the evolution and structure of the cotton fibre	By Abraham Flatters, F.R.M.S. (*Messrs. Sherratt & Hughes.*)
My Experiences in the Island of Cyprus .	By B. Stewart. (*Messrs. Skeffington & Son.*)
On the Indian Hills, or Coffee Planting in Southern India	By Edwin Lester Arnold.

A Glimpse of the Tropics, or four months' cruising in the West Indies . . . By E. A. Hastings Jay, LL.B., F.R.G.S. (*Messrs. Sampson Low, Marston & Co.*)

Burma: A Handbook of Practical Information . . . . . . By Sir J. G. Scott, K.C.I.E. (*Messrs. Alexander Moring, Ltd.*)

A Historical Geography of the British Colonies. Vol. vi. Australasia . . By J. D. Rogers. (*Delegates of the Clarendon Press.*)

Notes on the Mineral Fuel Supply of Canada . . . . . . By R. W. Ells, LL.D. (*Mr. Watson.*)

Malay Tin Fields. The Mining position broadly reviewed . . . . By Ralph Stokes. (*Straits Times Press, Ltd.*)

Jahres-bericht des Export-Vereines fur Bohmen, Mahren und Schlesien in Prag fur das Jahr 1906 . . . (*The Secretary.*)

Associaçao Commercial do Porto: Relatorio da Direccao no anno de 1906 . (*The Secretary.*)

Rubber Cultivation in the British Empire. A lecture delivered before the Society of Arts . . . . . . By Herbert Wright. (*Messrs. Maclaren & Sons.*)

Transactions of the Highland and Agricultural Society of Scotland, Vol. xix. . (*The Secretary.*)

Le Bananier . . . . . . By Paul Hubert. (*MM. H. Dunod & E. Pinat.*)

Queensland Geographical Journal (New Series). Including the Proceedings of the Royal Geographical Society of Australasia, Queensland. Vol. xxi., 1905–1906 . . . . . (*The Secretary.*)

Annual Report of the Wellington Chamber of Commerce for 1906 . . . . (*The Secretary.*)

The Imperial Gazetteer of India: The Indian Empire. Vol. i. Descriptive. Vol. iii. Economic. Vol. iv. Administrative . . . . . . (*Secretary of State for India.*)

Peat: its use and manufacture . . .	By Philip R. Bjorning & T. Frederick Gissing. (*Messrs. Chas. Griffin & Co.*)
The Proceedings and Transactions of the Nova Scotian Institute of Science, Vol. xi. Part ii., 1903–1904 . . .	(*The Secretary.*)
A Handbook of Cyprus, 1907 . .	(*The Crown Agents for the Colonies.*)
Proceedings of the Madras Chamber of Commerce, 1906	(*The Secretary.*)
Annual Report of the John Crerar Library, 1906	(*The Secretary.*)
A Souvenir of the Visit of the Colonial Premiers, 1907	By Frederick J. Johnston-Smith. (*Messrs. Wyman & Sons.*)
Annual Report of the Yokohama Foreign Board of Trade for the year 1906, and Minutes of the Annual General Meeting, 1907	(*The Secretary.*)
The Licensed Trade: An independent survey	By Edwin A. Pratt. (*The Author.*)
Handbook of the Federated Malay States	By H. Conway Belfield. (*Mr. Edward Stanford.*)
Index to Subjects, and names of authors appearing in the "Journal of the Royal United Institution" from 1887 to 1906	(*The Secretary.*)
Illustrated Coconut Manure Experiment	By Alfred Drieberg.
The Manuring of the Coconut Palm.	
The Rational Manuring of Tea in Ceylon.	
Notes on Coconut Cultivation in the Southern Province, Ceylon	By H. Amarasurinya.
Rubber Cultivation in Ceylon.	(*Messrs. Freudenberg & Co.*)
Practical Coal Mining, Vol. ii. . . .	Edited by W. S. Boulton, B.Sc., F.G.S. (*The Gresham Publishing Co.*)
Hints on the Collecting of Timber Specimens	By Herbert Stone, F.L.S., (*The Author.*)

BULLETIN

OF THE

IMPERIAL INSTITUTE

1907. VOL. V. NO. 3.

SCIENTIFIC AND TECHNICAL DEPARTMENT.

RECENT INVESTIGATIONS.

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Indian and Colonial Governments concerned.

ECONOMIC PRODUCTS FROM BRITISH EAST AFRICA.

A LARGE number of samples of mineral and vegetable products from British East Africa have been received at the Imperial Institute for examination during the last few years, and some of these have been dealt with already from time to time in this *Bulletin* (rubber, 1903, **1**. 68, 70; 1904, **2**. 153, 221; 1905, **3**. 146; fibres and cotton, 1905, **3**. 139, 226; 1906, **4**. 189, 291; timbers, 1906, **4**. 15). A *résumé* of information concerning the principal products of the Protectorate has also been published in an article dealing with the exhibits in the British East African Court of the Imperial Institute (1906, **4**. 272), reprints of which are now obtainable (see list on page 3 of cover of this *Bulletin*).

In the present article a number of other products are dealt with, many of which are likely to be of importance in connection with the development of the agricultural and mineral resources of the country.

BANANA FIBRES.

SEVEN samples of banana fibres have been forwarded to the Imperial Institute by the Director of Agriculture and Forestry, Nairobi, at various times for chemical examination and commercial valuation.

Description of Samples.

No. 1.—This sample, labelled "No. 21/05, Nandi banana fibre," consisted of $5\frac{1}{2}$ lb. of fairly lustrous light-brown fibre, which was well cleaned and prepared and of good strength. The greater part of the sample had a length of 3 feet 5 inches to 4 feet 3 inches, but some shorter fibre, about 2 to 3 feet long, was also present. In the letter from the Director of Agriculture and Forestry, it was stated that the product had been prepared by natives probably from *Musa Livingstoniana*.

No. 2.—This sample, labelled "No. 22/05, Kericho banana fibre," consisted of 1 lb. of fibre, which resembled the preceding sample in appearance, but was rather more lustrous, lighter in colour, somewhat finer, not quite so strong, and varied in length from 4 to 5 feet."

No. 3.—This was probably derived from *M. Livingstoniana*, and consisted of $1\frac{1}{2}$ lb. of fibre, which was of a brown colour, well prepared, lustrous, soft to the touch, of good but somewhat uneven strength, and from 1 foot 9 inches to 3 feet 8 inches long.

A.—This sample, labelled "No. 23/05, Mwatate banana fibre," consisted of 4 lb. of coarse, light-brown, somewhat lustrous fibre, which was fairly well cleaned and prepared, of fair but uneven strength, and from 4 to 6 feet long.

B.—This sample was labelled "No. 24/05 (*a*), Wild banana, claret-coloured variety. Tree past maturity and partly destroyed by fire. Weight of fibre, 1 lb." The fibre was fairly well cleaned and prepared, of fair lustre and strength, was coarser than the two following samples C and D, but less coarse than A. The length of the material varied from 5 to 6 feet. The product was of uneven colour, the greater part being cream-coloured, whilst a small proportion was stained dark brown.

C.—This sample was labelled "No. 24/05 (*b*), Wild banana, green variety. Tree about three-quarters grown. Weight of

fibre, 1 lb." The fibre was of an uneven pale cream colour with light-brown stains, was fairly well cleaned and prepared, strong, of good lustre, and 6 to 8 feet long.

D.—This was labelled "No. 24/05 (*c*), Wild banana fibre, claret-coloured variety. Plant about half grown. Weight of dry fibre, 1 lb." The fibre was fairly well cleaned and prepared, cream-coloured, lustrous, of good strength and 5 to 6 feet long.

Chemical Examination.

The results of the chemical examination of these samples of banana fibres are collected together in the following table, to which are added for convenience of comparison those furnished by samples of the fibres of *Musa Ensete* and *Musa ulugurensis* from German East Africa, which have also been examined in the Scientific and Technical Department, and have been described in this *Bulletin* already (1905, **3**. 226).

	Samples from British East Africa.							Samples from German East Africa.		
	No. 1.	No. 2.	No. 3.	Sample A.	Sample B.	Sample C.	Sample D.	*Musa Ensete*, Quality 1.	*Musa Ensete*, Quality 2.	*Musa ulugurensis.*
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	10·4	10·8	9·5	10·8	9·9	10·3	10·7	9·7	9·4	10·2
Ash	2·2	3·4	2·9	1·2	4·8	4·8	2·3	1·5	1·7	1·6
α-Hydrolysis (loss)	20·1	16·5	17·5	10·5	22·4	15·8	15·1	10·3	13·0	22·9
β-Hydrolysis (loss)	24·0	25·6	25·5	14·2	26·4	26·3	23·2	15·1	18·2	24·7
Acid purification (loss)	5·8	3·8	6·9	3·0	7·3	5·1	4·7	0·8	3·7	6·5
Cellulose	74·4	73·0	71·8	77·8	71·5	73·4	72·3	78·1	74·5	70·7
Length of ultimate fibre	1·4–2·5 mm. (0·06–0·10 in.)	1·6–3·1 mm. (0·06–0·12 in.)	1·5–6 mm. (0·06–0·24 in.)	—	—	—	—	2·6–5 mm. (0·10–0·20 in.)	2·6–5 mm. (0·10–0·20 in.)	2·2–4·7 mm. (0·09–0·19 in.)

Samples Nos. 1 *and* 2.—The results show that these banana fibres, although of good quality, are not equal to that of the *M. Ensete*, this being particularly noticeable in the amount of loss sustained on boiling with dilute alkali (α- and β-hydrolysis). They appear, however, to be somewhat superior to the *M. ulugurensis* fibre, since they contain a larger proportion of cellulose.

Sample No. 3.—It is evident that in chemical composition

and behaviour this fibre is inferior to that of *M. Ensete*, but compares favourably with that of *M. ulugurensis.* The sample of *M. ulugurensis*, however, was superior in colour, length, and general appearance, and was therefore more valuable.

Sample A.—On comparing the results given by this fibre with those furnished by the two fibres from German East Africa it is evident that in chemical composition and behaviour this sample compares favourably with *M. Ensete* (quality 1), since it is fairly resistant to the action of boiling dilute alkali, as shown by the comparatively small loss on α- and β-hydrolysis, and contains a high proportion of cellulose. The material is, however, much inferior in colour to the *M. Ensete* fibre.

Sample B.—This sample is somewhat inferior in chemical composition and behaviour to the samples A, C, and D sent at the same time, but resembles the *M. ulugurensis* fibre.

Sample C.—The figures show that this sample resembles B, but is somewhat richer in cellulose.

Sample D.—This sample, like B and C, resembles the *M. ulugurensis* fibre in chemical composition and behaviour.

Commercial Valuation.

Sample No. 1.—The commercial experts reported that this fibre was very strong, of fair length, and of colour similar to that of Manila hemp, but that a part of the sample consisted of short fibre. The product was valued at £31 to £32 per ton in the London market.

Sample No. 2.—This was reported to be very strong, soft, very fine, clean, of fairly good colour and length, and worth from £40 to £42 per ton.

These two valuations were based on the current prices of the best grades of Manila hemp, which varied at that time from £43 to £57 per ton.

Sample No. 3.—The commercial experts, to whom this sample was referred, reported that the fibre was short, soft, of dull yellowish colour and mixed strength, and worth about £20 to £22 per ton.

Sample A.—This was described as rather harsh, of yellowish colour and satisfactory length, and consisting of fibre of two

lengths, the shorter being worth £26 and the longer £30 per ton in the London market.

Sample B.—The commercial experts reported that this fibre was of satisfactory length, fair colour and good strength (with the exception of the stained portions, which were weak), and recommended that care should be taken that the juice of the plant does not stain the fibre, since thereby both the strength and commercial value of the product are depreciated. The material was valued at £34 to £35 per ton.

Sample C.—This fibre was regarded as of excellent quality well prepared, strong, and lustrous, and worth £48 to £50 per ton.

Sample D.—The commercial experts reported that this material was of good length, colour, and strength, had been carefully prepared, and was worth £45 to £46 per ton.

General Conclusions.

The results of the examination of these fibres show that, on the whole, the samples are well prepared and of good quality. In the opinion of the commercial experts, these products are comparable with the best fibres used for rope-making, are similar to the most expensive grades of Manila hemp, and would meet with a ready sale in the London market.

It is important to remember that in exporting such materials the fibre should be roughly sorted according to length, so that the value of the longer fibre may not be lessened by the presence of the shorter product, as is the case for example in Sample No. 1. Information as to the botanical identity of the plants from which these various samples are derived has been asked for.

FIBRE OF *Triumfetta semitriloba.*

This sample of fibre was forwarded to the Imperial Institute by the Director of Agriculture, Nairobi, in September 1904. It was very small, weighing only about ½ oz., and was not well prepared, a large part of the fibre adhering together owing to the material having been insufficiently cleaned. For these reasons it was impossible to carry out a complete chemical investigation, or to obtain a satisfactory commercial valuation. The fibre was

strong, of a light-brown colour, and the staple varied in length from 6 to 8 feet. A part of the sample, after being carefully hackled, was examined chemically, and gave the following results:—

	Per cent.
Moisture	9·5
Ash	1·7
Loss on a-hydrolysis	9·2
Cellulose	76·1

Length of ultimate fibre . 1·8–3·9 mm. (0·07–0·16 in.)
Average . 2·7 mm. (0·11 in.)

These figures show that the fibre is rich in cellulose, contains but a small proportion of mineral constituents (ash), and if properly prepared would be of good quality.

It is of interest to compare these figures with those furnished by the fibre of a closely allied plant, *Triumfetta rhomboidea*, a sample of which, grown in Nyasaland, has been examined recently at the Imperial Institute. The results given by a specimen of Indian jute of "extra fine quality" are also added for comparison.

	Triumfetta semitriloba fibre.	*Triumfetta rhomboidea* fibre.	"Extra fine" Indian jute.
	Per cent.	*Per cent.*	*Per cent.*
Moisture	9·5	10·4	9·6
Ash	1·7	0·6	0·7
Loss on a-hydrolysis	9·2	9·1	9·1
Cellulose	76·1	76·2	77·7
Length of ultimate fibre	1·8–3·9 mm. or 0·07–0·16 in.	2·0–2·8 mm. or 0·08–0·11 in.	1·5–3·0 mm. or 0·06–0·12 in.

A consideration of this table leads to the conclusion that the Triumfetta fibres are very similar in composition, and that well-prepared samples of *T. semitriloba* would be probably in no way inferior to the fibre of *T. rhomboidea*. Both fibres closely resemble jute in chemical properties and composition, as well as in the length of their ultimate fibre. The sample of *T. rhomboidea* fibre was valued by commercial experts in September 1904 at about £12 per ton in the London market.

From the results of this investigation, it is evident that the fibre of *T. semitriloba* possesses valuable qualities, and a larger and carefully cleaned sample of the fibre has been asked for, so that it may be more thoroughly examined, and its commercial value ascertained.

"TUOR" FIBRE.

This sample was received from the Acting Director of Agriculture in April of the present year. It weighed 9 oz., and consisted of clean, well-prepared fibre, pale yellow in colour, and of a fair lustre. No information was supplied regarding the botanical origin of the fibre, but a botanical specimen received subsequently was identified at Kew as *Sansevieria guineensis*. The strength of the fibre was very good, and its length of staple 3 feet. On analysis the following results were obtained :—

	Per cent.
Moisture	8·8
Ash	1·2
α-Hydrolysis (loss)	12·4
β-Hydrolysis (loss)	16·1
Acid purification (loss)	4·5
Cellulose	69·9
Length of ultimate fibre	1–5 mm.
Average	3 mm.

These results show that "Tuor" fibre is somewhat inferior in composition to a sample of *S. Ehrenbergii* fibre from Somaliland examined at the Imperial Institute (this *Bulletin*, 1906, **4**. 189), but is superior in strength, and on the whole is of very good quality and readily saleable. Commercial experts valued the sample at £32–£33 per ton, which was then about the current price of Mexican sisal hemp.

RAPHIA FIBRE.

This sample, produced at Taveta, consisted of about 1¼ lb. of raphia ribbons, which were of light-brown colour, well cleaned, and of good strength. The length of staple varied from 4 feet to 5 feet 6 inches. A portion of the sample was submitted to commercial experts for valuation.

They reported that it was similar to the "fair ordinary quality" of raphia fibre as now imported, and that it would be worth from £28 10*s.* to £29 per ton, but that if it could be obtained of lighter colour it would probably be worth from £1 to £1 10*s.* per ton more.

FIBRE OF *Adansonia digitata* ("Baobab" tree bark).

This sample consisted of 1¼ lb. of strips of reddish-brown bark fibre, which were free from adherent woody matter, and varied in length from 3 to 5 feet.

On chemical examination it yielded the following results:—

	Per cent.
Moisture	9·7
Ash	6·2
Cellulose	60·8

The ultimate fibre measured 3·5–5·3 mm. (or 0·14–0·21 inch), and had an average length 4·5 mm. (or 0·18 inch).

The commercial experts to whom the sample was submitted stated that the material used to sell at about £5 or £6 per ton for paper-making, but that since the introduction of wood pulps it is probably not worth more than £3 per ton.

Further information regarding this fibre is given in the *Bulletin of the Imperial Institute*, 1904, **2**. 169, and 1907, **5**. 107.

FLAX.

This sample of flax, grown in the Highlands of the East Africa Protectorate, was sent to the Imperial Institute by a commercial firm at Nairobi, who stated that the fibre was known as "Lin flax," and was grown at an altitude of about 5,600 feet.

The sample consisted of two bundles of flax fibre, weighing 1½ lb., which had been retted and broken. Most of the "shieve" or broken particles of wood had been removed in the scutching operation, but a small quantity remained in the sample. The fibre was lustrous and greyish-brown in colour. The strength was fairly good, and the length of the strands of fibre was 24 to 32 inches. The diameter of the strands was 0·0025 to 0·020 inch, and of the ultimate fibres 0·00056 inch with a variation between

0·0003 to 0·0009 inch. Microscopic examination showed that the fibre had the characteristic structure of flax.

The appearance of the sample suggested that the flax had been over-retted; consequently the fibres separate easily, and an abnormally large quantity of waste would be produced in the processes of manufacture. Fibre of this character is known in commerce as flax codilla. It is the product of over dew-retted flax straw.

The commercial value of flax codilla of the quality of the sample would be about £26 per ton delivered in Dundee. At the present time this class of material is in considerable demand, and the price quoted is about £3 or £4 above the ordinary value.

The straw from which the fibre was produced would no doubt have furnished with proper treatment the true flax of commerce, and also given a larger yield. Such fibre would be worth to-day from £30 to £35 per ton.

The quality of the sample indicates that further experiments in flax growing might well be made in the district where this fibre was produced.

LUMBUA RUBBER.

This sample of rubber, received in May 1904, consisted of a single split ball weighing about 1½ oz. The ball was dark reddish-brown throughout, and contained small fragments of vegetable matter distributed through it. The physical properties of the rubber were very satisfactory, it being quite free from stickiness and exhibiting good elasticity and tenacity.

An analysis was made for comparison with the results of previous examinations of East African rubber (*loc. cit.*) and furnished the following results:—

	Per cent.
Moisture	2·7
Caoutchouc	82·2
Resin	9·3
Insoluble matter	5·8
Ash	2·1

This analysis shows that, so far as chemical composition is concerned, the rubber is of very fair quality, though the per-

centage of resin is rather higher than is desirable. The amount of resin present in the previous samples of rubber from the East Africa Protectorate has ranged from about 4 to 13 per cent., so that this Lumbua rubber occupies an intermediate position in this respect. No information was furnished regarding the botanical origin of this sample.

The sample was rather small for commercial valuation, as a quotation based upon a single ball may not represent the value of a large consignment of rubber derived from the same source. Rubber equal to the sample would fetch from 3*s.* 6*d.* to 3*s.* 9*d.* per lb. in London when Para rubber is quoted at 4*s.* 10*d.* per lb.

"MGOA" RUBBER.

This sample was received from the Acting Conservator of Forests at Nairobi. It was labelled "Rubber from Shimba Hills," and consisted of a single ball of rubber, about 2¼ inches in diameter, and weighing 104 grams, evidently formed by winding threads of rubber upon a central mass; it was light-brown and contained a considerable quantity of vegetable impurity. The rubber was fairly strong.

Samples of the flowers and fruit of the tree yielding this rubber were sent recently by the Acting Conservator of Forests to the Royal Gardens, Kew. From this material the tree has been identified by Dr. Stapf as *Mascarenhasia elastica* (*Kew Bulletin*, 1907, 283).

On analysis the sample of rubber gave the following percentage results :—

	Sample as received.	*Composition of dry rubber.*
Moisture	10·0	—
Caoutchouc	69·0	76·6
Resin	6·1	6·8
Proteids	3·5	3·9
Insoluble matter	11·4	12·7
Ash	2·29	2·54

These results show that the sample is of fair quality though the amount of insoluble matter is rather high. This defect could be remedied by careful collection so as to exclude, as far as possible, fragments of bark from the rubber.

The sample was valued at 3*s*. 6*d*. per lb. in London; the current price of fine hard Para from South America being at that time 5*s*. 2*d*. per lb.

Consignments of this rubber, if well prepared, would be readily saleable at satisfactory prices.

OIL-SEED OF *Croton Elliotianus*.

A sample of the seeds of *C. Elliotianus* was forwarded to the Imperial Institute by the Director of Agriculture and Forestry at Nairobi in January 1906, for examination in order to determine the value of the oil which they contain.

The sample consisted of about 2½ lb. of decorticated seeds, some of which were found to have turned brown. Only the fresh ones were used in the examination.

The seeds were extracted by light petroleum, and yielded 27·7 per cent. of a yellowish oil.

On chemical examination the oil was found to possess the following constants, for comparison with which the corresponding figures for croton oil derived from *Croton tiglium* have been added.

	Oil of *Croton Elliotianus*.	Oil of *Croton tiglium*.
Specific gravity at 15° C.	0·9266	0·9428
Acid value[1]	4·24	—
Saponification value[1]	201·5	210–215
Iodine value, per cent.	138·5	101·7–102
Hehner value (percentage of insoluble acids)	94	88·9–89·1
Titer test (solidifying point of fatty acids)	13·7°–13·8° C.	—

[1] *Milligrams of potash required for one gram of oil.*

These constants show that the oil of *C. Elliotianus* is quite different from ordinary croton oil, the product of *C. tiglium*, and, unlike the latter, it does not appear to possess vesicating properties.

The oil of *C. Elliotianus* would be less suitable for soap-making than cotton seed oil, as the melting-point of the fatty acids is low, and it might be difficult to sell when large supplies of cotton seed oil are available. But under present conditions

when vegetable oils are scarce and dear this product could be readily disposed of at prices somewhat less than those secured for cotton seed oil.

TACCA "ARROWROOT."

A sample of this material prepared from the roots of *Tacca pinnatifida* grown in the Protectorate during the 1905 season was forwarded for valuation. It was dull white in colour, rather gritty, and when examined under the microscope showed the characteristic structure of Tacca starch granules.

This material is well known in the South Sea Islands, but rarely appears in European markets. The British East Africa sample was valued at 14*s.* 0*d.* per cwt., and it was stated by the commercial experts to whom it was submitted that it could be sold in the United Kingdom as a cheap manufacturing arrowroot. It is of course quite distinct in character from the true arrowroot produced in the West Indies from the roots of *Maranta arundinaceæ.*

BEANS.

A considerable amount of attention has been paid in the Protectorate to the cultivation of beans of various kinds suitable for use as feeding-stuffs, and samples of "Egyptian," and "dwarf" beans grown during the season 1904–1905 have been received for valuation. Both were described by experts as of good quality, and as regards the dwarf beans it was suggested that small consignments could probably be readily sold in the United Kingdom for seed purposes, and since then several small shipments of these beans have been made to the United Kingdom, where they appear to have given good results when used as seed.

FŒNUGREC.

The sample of this material submitted was described as about equal in quality to Bombay fœnugrec.

VARIOUS FOODSTUFFS.

Among other foodstuffs submitted were a sample of lentils, which was regarded by experts as similar to Calcutta lentils and

worth *21s.* to *22s.* per quarter, linseed which was valued at *40s.* to *42s. 6d.* yer quarter, "Egyptian barley" which was regarded as worth *22s.* per quarter, and coffee valued at *40s.* per cwt. The commercial experts who valued these four materials expressed the opinion that they would all be readily saleable in the United Kingdom, and it remains to be seen whether the yields obtained in the Protectorate will be remunerative at the prices quoted.

MINERAL PRODUCTS.

THE samples of economic minerals and soils described in the following paragraphs have been forwarded to the Imperial Institute by the Government of British East Africa at various times during the last few years.

LIMESTONE.

Two samples of limestone were received for examination early in 1905. They were stated to have been obtained in the vicinity of the Makindu Station of the Uganda Railway. No. 1 was a clean white limestone, permeated with irregular cavities. No. 2 was reddish-brown in colour, due to impregnation with iron compounds. On analysis the samples gave the following results:—

		Sample No. 1. *Per cent.*	*Sample No.* 2. *Per cent.*
Lime	CaO	48·72	47·50
Magnesia	MgO	—	2·90
Ferric oxide	Fe_2O_3	0·17	2·58
Alumina	Al_2O_3	0·44	3·00
Phosphoric oxide	P_2O_5	Trace	0·59
Carbon dioxide	CO_2	34·07	33·63
Residue insoluble in acids, chiefly silica	SiO_2	11·54	7·63
Moisture and combined water		5·01	2·42

Sample No. 1.—The results of the chemical examination show that this is a limestone of good quality. When burned it

affords a white lime which "slakes" vigorously. The "slaked lime" produced "sets" slowly on exposure to air, requiring several days to harden on the outer surface. In preparing "mortar" from this lime, owing to the presence of these quartz grains, it will be necessary to use a correspondingly smaller proportion of sand, and this precaution being taken it will be possible to make a satisfactory "mortar" suitable for all ordinary purposes from this material.

Sample No. 2.—The analysis of this limestone shows that it contains small amounts of iron, alumina, and magnesia in combination with silica. In consequence the slaked lime prepared from it has to a certain extent the properties of hydraulic limes, *i.e.* it hardens on exposure to air, not only as the result of absorbing carbon dioxide from the air, but also to a slight extent as the result of combining with water to form hydrated silicates such as are produced in "setting" of Portland cement. "Slaked lime" prepared from this material "sets" and hardens more quickly, therefore, than that prepared from sample No. 1. A number of mortar trials were made with slaked lime prepared from sample No. 2, and it was found that the admixture of from one to three parts of sand with each part of "slaked lime" used produced a mortar of fair quality, suitable for general use.

It is clear, therefore, that either of these limestones can be used for the manufacture of "slaked lime" which will be suitable for the production of "mortar" to be used for general building purposes.

IRONSTONE.

This sample of ironstone was received early in 1905. It was collected near Voi Station (mile 102) on the Uganda Railway. The sample weighed about 1 lb., and consisted of irregularly-shaped brownish lumps of magnetite. The "streak" of the mineral was black, and the specific gravity about 5·1. A few of the fragments showed inclusions of quartz.

Chemical Examination.

The sample of ironstone was analysed, and gave the following results:—

		Per cent.	
Ferric oxide . .	Fe_2O_3	. 66·98	*Together equal to* 63·2 *per cent. of metallic iron.*
Ferrous oxide .	FeO	. 21·01	
Manganous oxide .	MnO	. 0·26	
Lime . . .	CaO	. 0·33	
Baryta . . .	BaO	. 0·62	
Magnesia . .	MgO	. 0·25	
Titanium dioxide .	TiO_2	. 8·70	*Equal to* 5·2 *per cent. of titanium.*
Silica . . .	SiO_2	. 1·42	
Phosphoric anhydride	P_2O_5	. 0·03	*Equal to* 0·013 *per cent. of phosphorus.*
Sulphuric anhydride	SO_3	. 0·02	*Equal to* 0·008 *per cent. of sulphur.*
Combined water .	H_2O	. 0·55	

These results show that this is a rich iron ore, and that it is fairly free from sulphur and phosphorus. On the other hand, it contains a large proportion of titanium, which is an undesirable constituent from the iron-smelter's point of view, since it renders the ore difficult to work in the blast-furnace.

It is impossible to say with the information at present available whether this ore would be worth working, and inquiries as to the extent of the deposits of the material are being made. If it can be shown that ore of this quality is available in large quantities it will be worth while to go further into the question as to whether it can be smelted to yield a satisfactory iron.

COAL FROM MWELE.

A small sample of this coal was sent to the Imperial Institute in November 1903, in order that its composition might be determined. In the preliminary report made on this sample, it was pointed out that the coal when freed from impurities by crushing, sifting, and washing with water would be quite suitable for conversion into briquettes, and in that form could be utilised for steam raising and other purposes.

A second larger sample of this coal was received subsequently, and gave the following results on examination.

Description of Sample.

The coal, like the previous sample, was in a fragmental condition, the largest piece being about 3 inches in length. It was partly brown and partly dull black on weathered surfaces, but the fresh fracture was lustrous black. It had a hardness of about 2, and did not soil the fingers when handled. The structure was coarsely vesicular and somewhat laminated, the coarse vesicles between the laminæ being in many cases filled with sand and dust. The substance of the coal itself was permeated with very fine cylindrical pores, which probably represent the remains of woody vessels. A rough microscopical examination showed traces of the original woody structure. The average specific gravity of portions free from coarse vesicles was 0·91, so that even the most compact portions of the coal readily floated on water. This low specific gravity is due to the porosity of the material. The coal burned without emitting a flame, but required a fairly high temperature for ignition, and it deflagrated violently in a blowpipe flame.

The coal was chemically examined, and gave the following results. The results obtained by the analysis of the washed coal prepared from the first sample of coal from Mwele are added for convenience of comparison.

	Second Sample. Unwashed Coal. Per cent.	*First Sample. Washed Coal. Per cent.*
Fixed carbon	43·08	59·95
Volatile matter	27·80	26·17
Ash	16·07	3·50
Sulphur	0·03	—
Phosphorus	0·007	—
Moisture	13·05	10·38
Dirt (in crude coal)	—	31·00
Calorific value	4,419 cal.[1]	5,814 cal.[1]

[1] *1 calorie is the amount of heat required to raise the temperature of one gram of water from 0° to 1° Cent.*

The coal was found to be of a non-caking type, and to have a calorific power of 4,419 calories, *i.e.* 1 lb. of this coal when completely burned would raise the temperature of 4,419 lb. of water from 0° to 1° C., whence its evaporative power was

calculated as 8·23, *i.e.* 1 lb. of coal would be sufficient to convert 8·23 lb. of water at 100° C. into steam at the same temperature.

These results indicate that the Mwele coal in the natural condition represented by this sample is a fuel of poor quality, but the present specimen is much better than the first sample examined at the Imperial Institute, and in comparing results of the analyses of the two given in the above table it will be seen that the present sample, though analysed in the crude condition, gives results nearly as good as the washed specimen prepared from the previous one.

The best method of exploiting this coal will be to crush, sift, and wash it free from sand, etc., and then to convert the washed product into briquettes, in which condition it could be used for steam raising. The amount of volatile matter yielded by the coal is considerable, but the coal would be unsuitable for gas manufacture, as but little of the volatile matter is combustible.

SOILS.

Three samples of typical soils from British East Africa have been received from the Department of Agriculture. These were described as follows:—

No. 1/05. Soil of the lower lands, Malindi.
No. 2/05. „ „ higher lands, Malindi.
No. 19/05. „ „ Nairobi Farm.

The results of the analyses of the samples are as follows:—

Mechanical Analysis.

Constituents.	Size of constituents in millimetres.	Soil from lower lands, Malindi.	Soil from higher lands, Malindi.	Soil from Nairobi Farm.
		Per cent.	*Per cent.*	*Per cent.*
Grits	3–5	—	—	10·56
Grits	2–3	—	—	6·58
Grits	1·5–2	—	—	2·80
Grits	1·0–1·5	—	—	3·10
Fine grits	0·5–1·0	0·56	33·92	12·90
Coarse sand	0·2–0·5	4·86	49·70	9·72
Medium sand	0·15–0·2	2·93	1·50	5·46
Fine sand	0·10–0·15	9·87	3·86	5·64
Coarse silt	0·08–0·10	5·10	1·00	3·16
Large silt	0·06–0·08	3·17	0·68	3·66
Medium silt	0·03–0·06	8·87	0·68	8·28
Fine silt	0·01–0·03	9·26	1·66	3·26
Finest silt	0·001–0·01	6·67	3·92	4·56
Clay	0·001 and less	42·80	2·30	19·78
Moisture	—	5·40	0·44	0·53

Chemical Analysis.

		Soil from lower land, Malindi.	Soil from higher land, Malindi.	Soil from Nairobi Farm.
		Per cent.	*Per cent.*	*Per cent.*
Matter insoluble in acids		54·68	89·85	44·25
Silica	SiO_2	47·42	86·13	39·16
Alumina	Al_2O_3	5·79	3·01	4·13
Ferric oxide	Fe_2O_3	0·42	0·01	0·43
Manganous oxide	MnO	—	—	—
Lime	CaO	0·81	0·43	0·35
Magnesia	MgO	0·24	0·27	0·18
Matter soluble in acids				
Silica	SiO_2	—	0·14	0·32
Alumina	Al_2O_3	16·62	3·03	17·96
Ferric oxide	Fe_2O_3	7·50	1·71	15·46
Manganous oxide	MnO	0·13	0·12	0·07
Lime	CaO	0·78	0·24	0·46
Magnesia	MgO	1·09	0·17	0·22
Potash	K_2O	1·43	0·76	1·72
Soda	Wa_2O	1·13	0·83	1·33
Phosphoric acid	P_2O_5	0·06	0·06	0·0007
Sulphuric acid	SO_3	0·05	0·05	0·06
Chlorine	Cl	0·17	0·17	0·10
Carbonic acid	CO_2	nil	nil	trace
Organic matter		6·00	0·40[1]	5·38[1]
Combined water	H_2O	4·75	1·71	11·99
Moisture		5·40	0·44	0·53

[1] *Principally charcoal, probably derived from the burning of refuse on the ground.*

	Soil from lower land, Malindi.		Soil from higher land, Malindi.		Soil from Nairobi Farm.	
	Per cent.	*Pounds per acre.*	*Per cent.*	*Pounds per acre.*	*Per cent.*	*Pounds per acre.*
Available potash, K_2O	0·0306	765	0·0073	182	0·0324	810
Available phosphoric acid, P_2O_5	0·0254	635	0·0077	194	0·0004	9·5
Total nitrogen	0·19	4751	0·05	1250	0·29	7350

The "available potash" and "available phosphoric acid" were determined by Dyer's method. The values in pounds per acre were calculated for a depth of 9 inches of soil.

The results of the mechanical and chemical analyses show that the soil from the lower lands of Malindi (No. 1/05) contains a large proportion of clay, and that when mixed with a small quantity of water it forms a stiff plastic mass, which is somewhat impervious to air and water. Such a soil can be maintained in good cultivation only with diffi-

culty, and to restore it to good condition after the rainy season would probably require an excessive amount of labour. The methods generally adopted for improving soils of this class are: (1) an efficient system of drainage, whereby a portion of the clay is gradually removed from the surface and aëration thus made possible; (2) shallow ploughing, in order to retain the improved surface soil; and (3) the plentiful application of lime.

The soil contains a fairly satisfactory proportion both of "nitrogen" and "potash," but is deficient in phosphoric acid. It would probably benefit, therefore, by the application of phosphatic manures.

The soil from the higher lands, Malindi (No. 2/05), differs markedly from that from the lower lands. It consists essentially, as the mechanical analysis shows, of fine grit and sand, and as is usually the case with soils of this type it contains comparatively little moisture. This soil is rather deficient in "nitrogen" and "phosphoric acid," though not more so than most unmanured sandy soils. There is a fair supply of "potash" in the soil, but this is not present in a form in which it is readily available as plant-food. The principal defects of soils of this type are, that (1) their power of absorbing water from the subsoil is small; (2) they do not retain moisture; and (3) the soluble constituents useful as plant-food are readily washed out of them. These defects may best be remedied by the application of lime and by "green manuring" (see this *Bulletin*, 1906, **4**. 118). The addition of lime to this soil would probably also convert the potash present in the soil into a form in which it could be more easily utilised by plants. The "green manuring" would gradually build up a reserve of "nitrogen" in the soil, but the deficiency in phosphoric acid would require to be remedied by the application of phosphatic manures.

The sample of soil (No. 19/05) from the Nairobi farm is, as regards its physical condition, intermediate between samples Nos. 1/05 and 2/05. It is much coarser in texture than either of the others, and in spite of the considerable proportion of "silt" and "clay" present, there is very little coherence between the particles, so that it has almost the appearance of a sand.

The particles are, however, somewhat pulverulent, and probably as this soil is worked its physical condition will become more satisfactory, and in particular the soil will begin to be more retentive of water. The chemical composition of this soil presents some rather unusual features. Thus, there is 20 per cent. of hydrated ferric oxide present, and to this is probably due its porous character. "Potash" and "nitrogen" are present in satisfactory amounts, but the quantity of phosphoric acid present is almost negligible. This deficiency in phosphoric acid seems to be common throughout East Africa, and has been observed, for example, in typical soils from German East Africa. These various defects could best be remedied by the addition of organic manures to change the texture of the soil, and of lime (or ground limestone) and phosphatic manures to increase the plant-food constituents of the soil.

PARA RUBBER FROM THE FEDERATED MALAY STATES.

THESE samples of Para rubber (*Hevea brasiliensis*), which had been specially prepared in the Federated Malay States, were forwarded to the Imperial Institute by the Director of Agriculture at Kuala Lumpur, with a request that they should be submitted to chemical examination in order to determine their purity.

The samples, sixteen in number, have been examined and have furnished the following results (see p. 247).

A survey of these figures shows that the samples taken as a whole are of excellent quality, the amount of caoutchouc ranging from 92·64 to 96·35 per cent., the proteid from 1·35 to 3·18, the resin from 1·38 to 3·58, the ash from 0·14 to 0·56, and the moisture from 0·22 to 0·60 per cent. Four of the samples contain over 95 per cent. of caoutchouc, and in seven others the amount of this constituent lies between 94 and 95 per cent.

Sample.	Description.	Weight.	Moisture.	Ash.	Resin.	Proteids.	Caoutchouc.
		grams.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1.	Crêpe, pale yellow . .	245	0·22	0·16	2·75	2·27	94·60
2.	Large thin biscuits, pale.	225	0·36	0·29	2·23	2·31	94·81
3.	Thin sheets, pale, opaque	255	0·54	0·48	1·64	2·66	94·68
4.	Crêpe, almost white . .	180	0·26	0·34	3·58	3·18	92·64
5.	Crêpe, dark brown . .	235	0·60	0·56	2·89	2·50	93·45
6.	Sheet, very pale . . .	230	0·38	0·36	1·78	3·08	94·40
7.	Crêpe, almost white . .	260	0·32	0·18	2·83	2·99	93·68
8.	Large biscuit, pale . .	250	0·42	0·46	1·38	2·13	95·61
9.	Crêpe, light brown . .	240	0·28	0·23	2·82	2·19	94·48
10.	Corrugated sheet, rather dark	280	0·44	0·35	2·45	1·94	94·82
11.	Corrugated sheet, pale .	280	0·38	0·28	1·83	2·36	95·15
12.	Corrugated sheet, rather dark	280	0·36	0·34	2·07	2·36	94·87
13.	Corrugated sheet, pale .	320	0·52	0·43	2·57	3·06	93·42
14.	Crêpe, yellow	300	0·42	0·14	3·01	2·90	93·53
15.	Thin sheet, pale . . .	280	0·22	0·21	1·87	1·35	96·35
16.	Sheet, pale	340	0·38	0·27	1·75	2·13	95·47
Minimum values		—	0·22	0·14	1·38	1·35	92·64
Maximum values		—	0·60	0·56	3·58	3·18	96·35

In the following table the eleven samples, containing over 94 per cent. of caoutchouc, are arranged according to the amount of this constituent present:—

	Moisture.	Ash	Resin.	Proteid.	Caoutchouc.
1. (No. 15) .	0·22	0·21	1·87	1·35	96·35
2. (No. 8) .	0·42	0·46	1·38	2·13	95·61
3. (No. 16) .	0·38	0·27	1·75	2·13	95·47
4. (No. 11) .	0·38	0·28	1·83	2·36	95·15
5. (No. 12) .	0·36	0·34	2·07	2·36	94·87
6. (No. 10) .	0·44	0·35	2·45	1·94	94·82
7. (No. 2) .	0·36	0·29	2·23	2·31	94·81
8. (No. 3) .	0·54	0·48	1·64	2·66	94·68
9. (No. 1) .	0·22	0·16	2·75	2·27	94·60
10. (No. 9) .	0·28	0·23	2·82	2·19	94·48
11. (No. 6) .	0·38	0·36	1·78	3·08	94·40

It will be seen from this table that sample No. 15, which contains the highest percentage of caoutchouc, has the lowest percentages of proteid and moisture in the series, whilst the amount of ash is also low and not much above the minimum

value; the percentage of resin is, however, a little higher than in the other three samples containing over 95 per cent. of caoutchouc.

The results of these analyses are of interest as indicating the high degree of purity which can be attained in the preparation of Para rubber from cultivated trees in the Federated Malay States. Corresponding figures for specimens of rubber shown at the Rubber Exhibition in Ceylon are given in a previous number of this *Bulletin* (1907, 5. 49), and may be consulted for comparison.

RUBBERS FROM THE GOLD COAST.

THESE rubbers were forwarded for examination to the Imperial Institute by the Director of Agriculture in the Gold Coast. The samples included specimens of the following rubbers: (1) Ceara rubber from *Manihot Glaziovii;* (2) Assam rubber from *Ficus elastica;* (3) "Krepi Ball" rubber from *Landolphia owariensis;* and (4) "Ofruntum" rubber from *Funtumia elastica.*

CEARA RUBBER (*Manihot Glaziovii*).

This sample was prepared from trees growing in the Botanic Gardens at Aburi. It weighed 35 grams, and consisted principally of loosely aggregated shreds of rubber, together with a few small compact pieces. The rubber was light brown, free from vegetable impurity, and exhibited very fair elasticity and tenacity.

It furnished the following results on analysis:—

	Per cent.
Moisture	4·4
Caoutchouc	67·7
Resin	4·4
Proteids	20·4
Ash	3·1

The only noteworthy feature of the analytical results is the

large amount of proteid present, but this is not unusual in the case of Ceara rubber. The percentage of resin is low.

The rubber was submitted for commercial valuation to brokers, who described it as good pale Ceara rubber of scrap character. They considered that material equal to the sample would probably realise 3*s.* 6*d.* per lb. in London. For comparison with this and the succeeding valuations it may be noted that the current value of fine hard Para rubber from South America was 5*s.* 4*d.* per lb., whilst Para "biscuits" from Ceylon and the Federated Malay States were quoted at 6*s.* 1½*d.* per lb.

ASSAM RUBBER (*Ficus elastica*).

The sample of this rubber was prepared from trees growing in the Botanic Gardens at Aburi. It weighed 50 grams, and consisted of aggregated shreds of rubber, which varied in colour from light brown to red, the latter predominating; a small amount of vegetable impurity was present. The rubber exhibited very good elasticity and tenacity.

The results of the chemical examination were as follows:—

	Per cent.
Moisture	1·5
Caoutchouc	80·1
Resin	11·6
Proteids	2·6
Insoluble matter	4·2
Ash	1·12

The rubber is therefore of very fair quality, containing over 80 per cent. of caoutchouc, though the percentage of resin is a little high.

It was valued at from 4*s.* 3*d.* to 4*s.* 6*d.* per lb. in London.

"KREPI BALL" RUBBER (*Landolphia owariensis*).

The sample of this rubber was collected in Larteh and consisted of three small balls, together weighing 94 grams. The rubber was brown, and contained a small amount of impurity in the form of fragments of bark; it exhibited very good physical properties, being strong and very elastic.

The following results were obtained on analysis :—

	Per cent.
Moisture	1·0
Caoutchouc	91·3
Resin	4·7
Proteids	0·9
Insoluble matter	2·1
Ash	0·42

It is evident from these figures that this rubber is of very good quality, over 90 per cent. of caoutchouc being present. The percentages of resin and proteids are low, the amount of the latter constituent being exceptionally small.

The brokers described the rubber as clean, dark ball, and valued it at 4*s.* 3*d.* to 4*s.* 6*d.* per lb. in London.

"OFRUNTUM" RUBBER (*Funtumia elastica*).

Two samples of this rubber were submitted for examination.

"Sample No. XI. Collected near Aburi. Latex coagulated by exposure to atmosphere."—This weighed 135 grams and consisted of a single thick "biscuit" of rubber, which was almost black externally but showed a few white patches internally when freshly cut. The rubber exhibited very good elasticity and tenacity.

"Sample No. XII. Collected near Aburi. Latex coagulated by boiling."—It weighed 128 grams and consisted of a single sheet of rubber, brownish-black externally but whitish within when freshly cut. The rubber exhibited very good elasticity and tenacity, but was not quite equal in appearance to No. XI.

The chemical examination gave the following results, and for comparison of the two samples the figures representing the composition of the dry rubber have been added :—

	Samples as received.		Composition of dry rubber.	
	No. XI.	No. XII.	No. XI.	No. XII.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	7·9	6·3	—	—
Caoutchouc	78·0	81·5	84·6	86·9
Resin	5·3	8·5	5·8	9·1
Proteids	7·6	3·2	8·3	3·4
Ash	1·2	0·5	1·3	0·6

It will be observed from a comparison of these figures that the two samples of Funtumia rubber vary considerably in the proportions of certain constituents, although the percentages of caoutchouc in the dry materials are approximately the same. Sample No. XII. contains much more resin than No. XI., but on the other hand the amounts of proteids and ash in No. XII. are less than half the quantities found in No. XI. The difference in the method of preparation is no doubt responsible for the higher percentages of proteids and ash present in No. XI.

The two samples of rubber were submitted to brokers for valuation. No. XI. was described as clean black sheet, well prepared, and was valued at 5*s.* 3*d.* per lb. in London. No. XII. was stated to be slightly inferior to the preceding sample, and was valued at 4*s.* 6*d.* per lb.

PEAT FROM THE FALKLAND ISLANDS.

FOUR samples of peat taken from the extensive deposits of this material which occur in the islands were sent to the Imperial Institute by the Governor for examination.

Sample No. 1.—This sample weighed about 10 lb., and was described as "Brown mossy peat; the first sod obtained after removing the top sod."

The material consisted of the dried and partially-decayed remains of the moss from which the peat is formed. It was very loosely compacted and could be readily disintegrated. This kind of peat is chiefly utilised as litter for stable use in place of straw. In Europe there has been a constantly increasing demand for material of this type, which, on account of its absorbent and antiseptic properties, forms a cleaner litter and, when spent, is a more valuable manure than straw.

Sample No. 2.—This sample weighed about half a hundredweight, and was described as "Black peat; one or two years old, obtained at a depth of from 2 to 4 feet."

The material consisted of blocks of peat, which were black and dull and contained plant remains still showing structure. It contained a quantity of the soil in which the moss had grown, as is shown by the higher percentage of ash, and would be described as "mud peat."

Sample No. 3.—This sample weighed about 20 lb., and was described as "Black peat obtained at a depth of 9 feet."

This peat contained more plant remains than No. 2, and this fact may indicate its derivation from a drier locality in which decay has not been so rapid.

Sample No. 4.—This sample of peat from West Point Island was forwarded by the Governor of the Falkland Islands at a later date than the first three samples.

It weighed about 7¼ lb., was black, tough, and compact, and had a specific gravity of 1·38.

In general physical characters the material somewhat resembled No. 3 of the samples previously submitted, but was rather more compact. The appearance of the peat almost suggested that of lignite.

Results of Examination.

The following are the results of the chemical examination of the four samples :—

	I.	II.	III.	IV.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Ash	2·71	6·52	2·72	10·00
Moisture (at 100° C.)	11·13	31·29	37·23	13·55
Volatile matter	57·26	35·39	39·17	49·87
Fixed carbon	28·90	26·80	20·88	26·58
	100·00	100·00	100·00	100·00
	Calories.[1]	Calories.	Calories.	Calories.
Calorific value	4,728	4,241	4,033	4,658

[1] 1 *calorie is the amount of heat required to raise* 1 *gram of water from* 0° *to* 1° C.

The ash was analysed, but the percentages of potash, lime, and phosphoric acid present are too low to make the ash of value as a fertiliser.

Conclusions and Recommendations.

Compared with peat from other sources Nos. 3 and 4 of the present samples may be said to be of the best quality, whilst No. 2 is of average quality. Analyses of European peat show that the amount of mineral matter (ash) present varies from 1 to 25 per cent., the average being about 5 per cent. The calorific values, determined by the bomb calorimeter, of the samples (Nos. 2, 3, and 4) which are suitable for fuel were 4,241 4,033, and 4,658 respectively. The calorific value would be increased by briquetting, since in this process a large proportion of the water would be eliminated.

A noteworthy point about the results of the analysis of the peat from West Point Island (sample No. 4) is the small percentage of moisture present, which is a very satisfactory feature. It will be seen from the above table that samples Nos. 2 and 3 contained over 30 per cent. of moisture when received at the Imperial Institute, whereas sample No. 4 contained only 13·55 per cent. In consequence of the drier condition of the peat from West Point Island its analysis shows higher percentages of volatile matter and fixed carbon than the others, and its calorific value is correspondingly increased, the fuel value of the peat is therefore greater. Sample No. 3 of the earlier specimens, when dried by exposure to the air, finally retained from 12 to 16 per cent. of moisture, and an analysis of a portion containing about 12 per cent. of moisture gave similar results to those obtained for sample No. 4. The low percentage of moisture in sample No. 4 is probably due to its having been exposed to the air before shipment.

As it seemed likely that this peat from the Falkland Islands would yield a compressed fuel of good quality, full information regarding modern methods of compressing and briquetting peat was supplied to the Governor, and as a result proposals have been received from a South American syndicate to work the deposits with a view to producing compressed peat fuel for consumers in the islands and on the South American mainland.

IRON ORE FROM PARAPARA, NEW ZEALAND.

In 1895 a sample of iron ore from Parapara was examined in the Scientific and Technical Department of the Imperial Institute, and the results of the examination are recorded in *Technical Reports and Scientific Papers*, p. 22, published by the Imperial Institute in 1902.

The present sample was forwarded by the High Commissioner for New Zealand in January 1906, with a request that it should be examined and a report on its quality furnished.

Description of Sample.

The sample weighed 10 lb., and was labelled "Iron ore from Parapara, New Zealand." It was a compact iron ore varying in colour from light yellow to dark brown, and showing in the cavities the glossy surface characteristic of limonite.

Results of Examination.

The ore was analysed and the results are given in the following table, which also includes the composition of the previous sample for comparison.

		Present Sample, 1906.	*Sample examined in* 1895.
Ferric oxide	Fe_2O_3	83·56 (Equivalent to 58·49 per cent. metallic iron)	76·26 (Equivalent to 53·38 per cent. metallic iron)
Manganous oxide	MnO	0·72	trace
Alumina	Al_2O_3	0·92	0·13 (Including phosphates)
Magnesia	MgO	0·31	—
Silica	SiO_2	2·2	12·41
Phosphoric oxide	P_2O_5	0·14 (Equivalent to 0·061 per cent. phosphorus)	trace
Sulphur trioxide	SO_3	0·21 (Equivalent to 0·084 per cent. sulphur)	trace
Carbon dioxide	CO_2	0·59	—
Water	H_2O	11·12	10·87
Moisture (at 100° C.)	—	0·21	1·24

These results indicate that the ore is probably a mixture of the two minerals göthite and limonite. The present sample is of good quality, the important impurities silica, phosphorus, and sulphur being present only in small quantities.

Conclusions.

This sample of iron ore from Parapara is of better quality than that examined in 1895, as it contains far less earthy impurity. In quality it is similar to much of the Spanish ore now largely imported into the United Kingdom, and is suitable for smelting by the acid process. Spanish ore is at present worth from 10*s.* to 11*s.* per ton f. o. b. at the port of shipment.

There is no doubt that this ore from Parapara would be suitable for smelting locally if supplies of limestone and coal are available in the neighbourhood, and from the information supplied in forwarding the sample of 1895 this would appear to be the case.

GENERAL NOTICES RESPECTING ECONOMIC PRODUCTS AND THEIR DEVELOPMENT.

VEGETABLE PRODUCTS OF KONTAGORA PROVINCE, NORTHERN NIGERIA.

THE following account of the vegetable products of the province of Kontagora has been prepared by Dr. J. M. Dalziel, one of the medical officers for Northern Nigeria.

The natural features of the district around the town of Kontagora are those of the open bush with coarse grass and undergrowth, numerous shrubs, and scattered trees constituting the type of savannah, which covers a considerable area of the Protectorate of Northern Nigeria. It is therefore unlikely that the floral types of this region should differ much from those found over an extensive area, and new species are hardly to be expected. Throughout the province, however, there are numerous ravines fed by perennial watercourses, and presenting

the common features of tropical African foliage. In such spots it is possible that a patient search, conducted throughout all the seasons of one year at least, might furnish some species of very local distribution, and perhaps some new to science. A collection of nearly 300 plants made by the writer during the dry season, from November 1905 to February 1906, in the neighbourhood of Kontagora, although including a few species gathered in such ravines, contains for the most part specimens which have probably a fairly wide distribution in the Protectorate, but pending the identification of these a few notes on the general botanical features and on the economic products of the neighbourhood may be of interest.

While the weeds in the cultivated fields and waste places both within and outside the town are chiefly coarse species of *Compositæ*, an order remarkably scarce in representatives in this country, the common herbs and suffrutescent plants forming the undergrowth of the bush belong for the most part to various genera of *Leguminosæ* such as *Crotalaria*, *Indigofera*, and *Tephrosia*. This, one of the most extensive of all natural orders in all countries, as well as one of the most useful to man, is well represented both in the wild flora, herbaceous and arborescent, and in cultivation.

The most striking tree of this order is *Daniella thurifera*, which is perhaps the commonest large tree throughout the district. Apart from the well-known balsam (*Daniella thurifera* is said to be the source of Ilorin or West African balsam of copaiba) which it yields, planed samples of the wood show an excellent grain, which, in small manufactured articles, closely resembles that of mahogany. As the trees not only are commonly 50 to 60 feet in height, but are frequently unbranched to a considerable distance from the ground, they would seem to afford a hopeful source of timber.

An equally lofty and more spreading tree of the same order, and one which is found equally in the bush and near dwellings, is called "kawo" (*Afzelia quanzensis*). It bears dark pods of a remarkably dense woody texture. An aged specimen with umbrella-like crown is often an attractive object in town or village. The wood has some features in common with teak, and may prove a useful timber.

Another leguminous tree of no little interest is one called "makarufo" by the Hausas. It is a species of *Dalbergia*, but its identity has not yet been fully determined. The heart wood is exceedingly dense and dark-coloured, suggesting the appearance of "lignum vitæ" when fresh, but the tree rarely exceeds a height of 20 to 25 feet. A large specimen occurs at the verge of the railway-line between Robert's Camp and Barijuko at about the 16th mile from Zungeru. It has, however, another interest, since the root provides one of the ingredients in a local recipe for the preparation of arrow-poison. It is also medicinal, and a small piece of the root added to "bammi" or palm-wine adds an element to the intoxication produced by the latter. This tree is very abundant in Kontagora province, and is one of the commonest components of the woods between Zaria and Zungeru. I observed it again plentifully in Lokoja.

The "dorowa" (*Parkia filicoidea*) is of course abundant here as elsewhere in the Protectorate. It flowers from the end of January to April, and when in flower exudes a gum, which drops from the branches to the injury of the coat of any horse which happens to be tethered beneath it. The pods yield a well-known article of native food, but the timber is too soft to be of use in carpentry. An analysis of the pods has been published in a report entitled: *Cotton, Gum, and other Economic Products from Northern Nigeria*, by Prof. W. R. Dunstan, F.R.S. [Cd. 2778]. Several varieties of *Acacia* and *Albizzia* are amongst the commonest trees in the bush, and most of them yield some form of gum. The species known as "*farin-khaza*" (or whitethorn) is perhaps the most frequent. Another acacia called "gawo" is rare so far south as Kontagora, and I have seen only one large specimen, near the hills of Odara six miles from the town, but it becomes increasingly abundant as one proceeds northward to Sokoto, where it is almost the predominant tree. It has no special uses. The *Acacia Farnesiana*, so widely distributed both in tropical and some temperate climates, was not observed in Kontagora, but the "baggarua" (*Acacia arabica*) is common, and its indented pods are the usual material for tanning there, not the bark as in some other places. This is the same tree as that known as "sant" or "sunt" in the Sudan and "babul" in India. (Analyses of the

pods and bark from the Sudan have been published already in this *Bulletin* [1906, **4**. 95].)

"Bagamma" is a common tree in the bush with long cylindrical pods used as a fish poison. It is abundant in Kontagora and Zaria, and between Sokoto and Kano, and is probably to be identified as *Cassia Sieberiana.*

Bauhinia reticulata or "kalgo," with its bifid leaf characteristic of the genus, accounting for the popular name "Camel's hoof" in the East, is one of the most frequent shrubs in the bush. Although the bark is rich in tannin, and in other parts of Africa is used as an astringent, it has no such application in Kontagora, where the only use to which the natives appear to put it is as a tooth-brush stick. An infusion of the leaves of this plant has been suggested as a medium for coagulating the latex of *Funtumia elastica.*

The "tsamia" (*Tamarindus indica*) grows well in Kontagora, but appears to be scarce further south, and is certainly not indigenous. Throughout Northern Nigeria the pulp of its fruit is usually dry and much inferior to that from the East Indies or from Brazil. Although in India the timber is sometimes used as a cabinet-wood, it is not likely to be exploited as timber in the Protectorate. Of economic *Leguminosæ* requiring the help of man to secure continuance of species there are perhaps none of special interest, the common types being here cultivated as elsewhere, *e.g.* the ground nut (*Arachis hypogæa*), the "earth pea" or "Kawaruru" (*Voandzeia subterranea*) the common bean of the country, and various species of *Indigofera.* A useful addition to these is the "pigeon-pea" or "dhal," which was grown from seed supplied from the Botanic Garden, Zungeru, in the spring of 1905. Although here, as in some parts of China and elsewhere, it acquires the habit of a tall shrub growing to 8 or 9 feet in height, it fructifies profusely, flowers appearing at the end of October and bearing an abundant crop of peas in December and the following months. This pea, which it is hoped the natives will now cultivate more extensively, is not altogether unknown in Northern Nigeria, though it does not appear to have established itself as a favourite agricultural product. It has been introduced in past years from Lagos, and is accordingly known as "wake-n-turawa," but another name

sometimes heard is "wake-n-damfammi," referring to the use of its stems in making fences, etc. In spite of its botanical name it is believed to be of African origin. The paucity of cultivated types of *Leguminosæ* is in curious contrast to the abundance and variety of wild species, and possibly the scarcity of lime in the soil may to some extent prevent the ready establishment of many varieties of leguminous vegetables, though the existing species appear to do as well as can be expected from the desultory methods of the cultivators. In the ravines the *Leguminosæ* are again prominent, and include some of the most conspicuous forest twiners, a notable and unpleasant example being a species of *Mucuna* (*Mucuna pruriens*,* D.C.), called "Karrara," closely related to the Calabar bean (*Physostigma venenosum*). To incautiously come in contact with the pods of this vine is a calamity which involves hours of tingling and uncontrollable itching, caused by the fine, velvety-looking pile composed of spicules like those of the prickly pear.

Amongst economic plants of other natural orders, cotton is of considerable interest. Although not by any means well raised, the people would seem to bestow more care on its cultivation than on any other crop, areas of cotton usually showing more evidence of attention and industry even than those devoted to other produce more necessary to life. The quality appears good, and the soil and surface conditions for a considerable radius around the town of Kontagora, and in many other parts of the province, should be well suited for this industry, from which so much is reasonably hoped at present. To the same order, *Malvaceæ*, belong the "yakua" (*Hibiscus Sabdariffa*),* with acid leaves like those of the sour-dock (*Rumex Acetosella*); a good antiscorbutic and pot herb, the flowers and fruit of which are sold in the markets under the name of "tusure" and used in soup; the okra or "kubewa" (*Hibiscus esculentus*), and another species of *Hibiscus*, commonly planted in native compounds, growing to a height of 10 feet and affording a fibrous bark suitable for rope-making. The bark of the common wild shrub

* *This and the other botanical names similarly marked in this article are taken from a list of identifications, supplied by the Director of the Royal Gardens, Kew, of herbarium specimens collected by Dr. Dalziel.*

of many countries, *Urena lobata*, of the same order, is sometimes similarly used, and of course the bark of the "kuka" or baobab (*Adansonia digitata*) is much used as a coarse textile. *Corchorus olitorius*, belonging to the well-known jute family (*Tiliaceæ*), occurs in the bush, but I have not observed that it is ever utilised. A species of *Sansevieria*, (the bowstring hemp) of India and Ceylon, called "modah" in Hausa, is found in native compounds, but though sometimes used as a fibre its chief use is medicinal. (For further information on the cotton produced in Northern Nigeria and the fibre-yielding plants of Nigeria and other West African Colonies and Protectorates, previous articles in this *Bulletin* should be consulted, especially 1905, **3.** 49; 1906, **4.** 349; 1907, **5.** 1 and 107.)

The common cereals are guinea corn (*Sorghum vulgare*), a red and a white variety, and the two so-called millets "gero" and "maiwa," species of *Pennisetum*. The soil is well suited both for the cultivation of guinea corn and of the others, though "gero" can be raised in localities too dry to support the former. Maize is grown in some parts, but not extensively near Kontagora town; smaller grains are frequently seen, such as that known as "tamba," a many-spiked form of millet, and a small grass called "makarri," perhaps some variety of *Eleusine indica* or *Eleusine corocana*. *Eragrostis tremula*,* known as "bamburrua," grows wild abundantly in the neighbourhood of cultivated fields, and is of interest as it affords a scanty substitute for other grains in time of famine. Rice is cultivated in some low-lying meadows, in marshes, and near streams, but the careful culture of this important cereal, as known in the East, is undreamt of here. In similar spots the "gwaza" (*Colocasia antiquorum* ?), with its enormous sagittate leaves, is planted, but here again the small tuber sold in the markets is tiny compared with the large "taro" of the East.

Both the "sugar sorghum" (*Sorghum saccharatum*) and the sugar-cane are grown in Kontagora. The first is called "takanda." It resembles guinea corn (*Sorghum vulgare*) in general habit, grows on any kind of soil, and is reaped before guinea corn is planted. The other is called "reke," and is the true *Saccharum officinarum* or one of its varieties. It is grown only at the sides of streams in moist situations, and is cut in

November and thereafter, about the same time or earlier than the guinea corn is harvested. No care is taken to secure thick succulent culms, and it is allowed to flower freely. This species was introduced by the Portuguese into West Africa from Brazil. Numerous other natural products of the district are quite the same as those found in many parts of Northern Nigeria, *e.g.* tobacco, yam, sweet potato, capsicum, tomato, cassava, sesamum, etc.

The lime is of course very abundant, but an interesting find in the market was a variety of orange. This, though of a rather coarse type, was quite succulent, and afforded an almost more pleasant drink than the juice of the lime. I found it growing on two fairly large trees in a native compound in the town, and though I am not aware of any other trees of this species in the neighbourhood, the supply lasted for several weeks in January and February. It is different from the oranges of the Lower Niger and the coast, and is said to have been introduced from North Africa.

The shea-butter tree or "kedanja" (*Butyrospermum Parkii*) flourishes throughout the province, and attains a large size. A sample of the wood was taken to Zungeru. With its deep red colour and excellent grain it is a tempting material for carpentry, but the value of the natural product of this tree will prevent it being cut for timber.

In the town of Kontagora an attractive exogenous tree is *Melia Azedarach*, known in the East as "Pride of India," "Bead tree," or "Persian lilac." As I observed seedlings of this tree in the gardens and flower-pots at the Government House in October 1905, and was informed by His Excellency the Acting High Commissioner, Mr. Wallace, that the seeds had been brought from Kontagora, it was the more interesting to find it there in the same month in full flower. It has been planted round the court-house, and is common in native compounds, but it is an introduced tree, as indicated by its native name, "kurna-na-sara," or "foreign kurna," kurna being the name for the common tree *Zizyphus jujuba*. It affords a good cabinet wood, not unlike teak, but rarely grows to a large size, and is subject during growth to injury by white ants, and its leaves to attacks by insects of the genus *Batocera*. This tree belongs to

the same order (*Meliaceæ*) as the African mahogany, *Khaya senegalensis*, which is scarce in the neighbourhood of Kontagora, but is frequently seen in the woods from Kontagora to Sokoto, in the Duru forest between Sokoto and Kano, and again between Kano and Zaria. It is known by the name of "madachi," and its bark is in such repute as a remedy for venereal and other diseases, that one rarely sees a specimen which has not been barked. An examination of the bark of this tree from Northern Nigeria, made recently at the Imperial Institute, showed that it contained about 10 per cent. of tannin. No well-defined product likely to be of medicinal value was found in it, so that such therapeutic value as it possesses is probably due to the tannin it contains.

Kontagora does not appear to be rich in sources of rubber, though specimens have from time to time been shown me chiefly from trees in the direction of Yelwa, and samples of rubber produced in Kontagora province are often brought for sale to stations on the Niger from Yelwa to Baro, *e.g.* "Balata" rubber obtained from *Ficus Vogelii*, a tree which the Hausas call "taba-ni-ka-sama," or "touch me and you get it," as well as "Ibo" rubber from *Landolphia florida*, and "Clustu" rubber. There are, of course, many species of *Ficus* in the neighbourhood, each with its own distinct native name—"durumi" and "baure," both of which have edible, but not very palatable, figs, "tschedia," "wa," "gamji," "kawarri," "baure-n-rafi," "baure-n-faddama," etc. All these have the milky juice of the genus, but not all are worth collecting, and they have little local use except as bird-lime to snare crickets, etc.; that of "gamji" is stronger, and is used to catch the "burtu" bird, the juice having been masticated to soften it, and then smeared on the false burtu head or mask which the hunter uses as a decoy. The only one of these species of *Ficus* which I have known to be tapped for rubber in Kontagora is that known as "kawarri," which, however, appears to be scarcer than the others. As I never saw it in fruit, I was unable to preserve specimens for botanical identification. The vine *Landolphia florida* grows freely wherever there are ravines with tall trees and perennial moisture. It is fairly abundant in the ravines at Mataitsebo and Odara, a few miles north of Kontagora, and "rubber," which is very resinous and of little com-

mercial value, is sometimes collected by the natives both from root and stem. Its orange-yellow fruit is edible, and ripens in April and May, when I saw them abundantly at many places on the route from Kano to Zaria and Zungeru.

Some other plants found in the district deserve passing mention, *e.g.* the castor oil shrub (*Ricinus communis*), and the leafless *Euphorbia Tirucalli*, with acid milky juice. These are both believed to be African in origin. *Jatropha Curcas*, or physic-nut, called here "chene-dazugu," a euphorbiaceous shrub sometimes planted as a hedge, is to be seen near the town. (Information regarding the seeds and the oil obtained from them has been given already in this *Bulletin*, 1904, **2.** 170.) It is of American origin, and in most countries is littoral in habit. In some parts of China the oil expressed from the seeds is used for lighting. In Kontagora the seeds are crushed and boiled, mixed with guinea-corn pap, and taken as a remedy for ascites, probably acting by causing diarrhœa.

The date palm is represented perhaps by the solitary specimen beside the mosque in the town. The "giginia" or "deleb" palm (*Borassus flabelliformis*), and the "goriba" or "dum" palm (*Hyphœne thebaica*), are most frequently seen.

Although greatly exceeded in height by the gigantic "rimi" or silk cotton tree (*Eriodendron anfractuosum*), the "kuka" or baobab (*Andansonia digitata*) is the predominant tree of inhabited places, and its manifold uses perhaps influence social life as greatly as its grotesque appearance adds scenic interest to a locality. (For an account of the composition of the fruit and leaves of this tree, see this *Bulletin*, 1906, **4.** 252.)

Before the end of the Harmattan, the brilliant red tulip-like blossoms of the "gurijia" (*Bombax buonopozense*) are a conspicuous feature of the wooded bush. The bark is used, mixed with tobacco-flowers, to improve the appearance of the teeth. The water-lettuce "kai-nua" (*Pistia Stratiotes*), common in most tropical countries, covers the stagnant pools in and near the town. The ash got by burning this plant is used in native medicine. "Garafine," a curcurbitous vine with relatively small yellow flowers, has the property of producing a lather when the leaves

or orange-yellow fruits are rubbed up in water. They are used as soap for washing the body, but not for clothing, with or without the addition of "potash," and the plant has also medicinal uses. The twiner is common in Zungeru, where it is a favourite in the native lines, and may be seen covering the soldiers' huts. The plants used in the preparation of arrow-poison afford interesting material for study. In Kontagora the chief ingredient is *Strophanthus* or "kwankwanni," of which two species are commonly used, viz. *Strophanthus hispidus*, and *Strophanthus sarmentosus.* Both of these are found near Kontagora, but there is a wide difference in their habitat, and the circumstances of their occurrence in the district, for the former being a shrub with long lax branches is capable of being grown in the neighbourhood of towns and villages, and is often found within the walls of these, affording a convenient supply, whereas the latter is a lofty woody climber supporting itself on rocks or on the tallest trees of the ravine, and its follicles have thus to be sought for in its natural habitat. *Strophanthus hispidus* has generally been looked upon as the chief source of the arrow-poisons, which are derived from plants of this genus, as distinguished from the genus *Acokanthera;* but I find that in Zungeru and in Kontagora the other species, *Strophanthus sarmentosus*, is more frequently employed, in Zungeru perhaps because it is much more abundant in the neighbourhood, indeed I have not seen *Strophanthus hispidus* there except in the form of seeds brought from a distance, and in Kontagora because native hunters say it is the more powerful poison. Many other ingredients, mostly from vegetable sources, are mixed with the *Strophanthus* seeds, and some of these, though not all, are themselves poisonous, but as these are in relatively small proportion, and as the list of them varies in different recipes, *Strophanthus* being the only constant ingredient, it is probable that they are of subsidiary importance. Some of them are as follows: "Tinia," or *Euphorbia arborescens;* "Makurufo," the root of the tree already mentioned as affording a wood resembling "lignum vitæ" and probably a species of *Dalbergia;* "Tefarshia," or *Sarcocephalus Russegeri* *; "Tururibi," a species of *Lasiosyphon*,* the root of which is declared to be one of the most virulent

poisons in the district; "Farin-doka," the bark of a leguminous tree (*Berlinia paniculata*) *; "Zabon-deffi" or *Aloe zebrina;* and "Womagunguna" or "Sainyia, *Securidaca longipedunculata*," * a leguminous shrub with masses of purple flowers. The list can readily be extended, but it is apparently not necessary to compound all these accessories in order to produce an active poison, and perhaps each district or even each hunter may have a slightly different formula. Several plants in the neighbourhood are believed to be antidotes, and one of the strongest proofs that the arrow-poisons of different districts, or at least of different, even though not distant, tribes are distinct is the fact that in war it is necessary to be prepared with antidotes of a more general application than those known by one tribe to be efficacious against their own poisons. Some of the commonest trees in the country are employed as sources of an antidote, *e.g.* the copaiba and the tamarind are both used in Kontagora, but the antidote of greatest repute both against local poisons and against those of unknown foes is derived from a shrub called "kirrne" (*Bridelia ferruginea*,* Benth). This is a euphorbiaceous tree, and is very abundant in Kontagora and Zungeru, and throughout Zaria Province. It need hardly be said that superstition plays an important part in the successful collecting and compounding of the various ingredients, and superstition finds application in connection with the uses of many other members of the vegetable kingdom. A humble wayside herb called "yauki," a species of *Crotalaria* not very commonly found, enables its fortunate possessor to pick out and overcome his enemy in war, himself remaining invulnerable. The common weed of waste places, called "baba jujhe," a species of *Boerhaavia*, is important to the hunter. The root mingled with the root of any tree under which he shoots his "beef" is placed inside the animal's eye, after piercing it to allow the fluids to escape, and the organ thus stuffed and worn as a charm renders the wearer invisible to his game. Trial by ordeal is probably not common in Kontagora, except amongst pagan tribes. A case of poisoning supposed to be due to sasswood (*Erythrophlœum guineense*) was reported once, but on inquiry this was not confirmed, and I do not think that sasswood grows

in the district. The pagans, however, use for the trial of witchcraft the bark of a tree called vaguely "itache-n-gwaska" ("ordeal tree"), which grows only in the forest and is not much known in Kontagora.

EXTENSION OF THE CULTIVATION OF JUTE AND SIMILAR FIBRES IN INDIA.

In view of the deficiency in the supply of jute and the consequent high price of the fibre, many attempts are being made at present in India and elsewhere to extend the cultivation of jute, or of fibres which can be used as substitutes for it.

A description of the cultural experiments carried out in West African Colonies in the cultivation of jute and similar fibres has been given in this *Bulletin* already (1905, **3**. 251; 1907, **5**. 1).

An account of a tour made by Mr. R. S. Finlow, B.Sc., F.C.S., has been published recently by the Agricultural Research Institute, Pusa, which contains much information of value to those interested in the cultivation of this crop. The tour was made during the period October 1905 to March 1906, and many places representing the more important types of country in the Bombay and Madras Presidencies and in the Central Provinces were visited. Much of the information deals with the kind of soil and the rainfall in the various districts compared with those of the jute-growing districts of Bengal, which at present produce nearly all the jute grown in India. From these and other data it is thought that the following districts in the provinces considered are most likely to yield successful results in jute cultivation:—

Bombay:
- Konkan or Coast Districts.
- Wet tract of the Deccan and Karnatak near the edge of the Ghats.
- Irrigated country round Poona.
- Irrigated districts of Sind.

Madras	Malabar Coast. Cauveri Delta. Kistna Delta. Godaveri Delta. Ganjam District.
Central Provinces	Nagpur Plain. Chhatisgarh Plain.

Parts of Bengal also, viz. Behar and Assam, which do not at present grow jute extensively are mentioned as suitable localities; some successful experiments have been made in Behar, and the cultivation is likely to extend, since in 1906 four estates had 1,000, 500, 400, and 300 acres respectively under jute, and in these cases the crops are said to be very good.

In Madras the climatic conditions are more favourable than in any of the other districts visited, the coast of Malabar having a climate somewhat similar to that of Bengal, and it seems probable that jute would thrive on the rice lands of Malabar and South Kanara. The 2,000,000 acres of irrigated land of the deltas of the Godaveri, Kistna, and Cauveri rivers may prove suitable, but difficulty is likely to be experienced in deciding the right time for sowing in these districts.

In Bombay any attempt to generalise on the possibility of jute cultivation is complicated by the very varying conditions of soil and climate, but on the whole Bombay seems to offer less chance of success than Madras. Judging from the water-supply (either by rainfall or irrigation) the only possible districts are those already mentioned. In the Deccan and Karnatak near the Ghats, wild jute grows on the embankments of the rice-fields, indicating that where the land is not too wet the conditions are suitable to jute. Experiments are to be carried out in the Bassein and "Poona irrigation" districts. In Sind the rainfall is small, and 99 per cent. of the total cultivated area was under irrigation in 1886. The soil here much resembles that of Bengal, although sometimes it is alkaline, which is detrimental to jute. Experiments are to be conducted in Lower Sind at the Mirpur Khas Government Agricultural Station, and in view of the very different conditions of climate and rainfall from those of Bengal, the results will be interesting.

In the Central Provinces experiments have been made already at Raipur, which were unsuccessful, probably owing to the plants being swamped due to late sowing. At Nagpur two experiments were made, and one was fairly successful; this is being repeated, and if successful will open up a considerable area.

As regards methods of cultivation of the plant, and preparation of the fibre, the directions given are practically identical with those detailed in a previous article in this *Bulletin* (1905, **3.** 251). Special stress is laid on the necessity for great care in the retting, as a well-grown crop may be very greatly reduced in value by either over- or under-retting; in the former case the fibre produced is gummy and in ribbons, while in the latter it is deficient in colour, strength, and gloss. A point to be noted is the desirability of retting the thick ends of the stems for 1–2 days by standing in water to a depth of 1–2 feet before immersing the whole of the stem, in order that the whole length of fibre may be completely retted at the same time. In this connection it may be mentioned that some of the samples of jute and jute substitutes recently received at the Imperial Institute for examination have obviously suffered from imperfect retting.

As jute is an exhausting crop it should not be grown on the same land for two consecutive years without liberal manuring; cow-dung is said to give good results, about 5 tons per acre being the usual quantity applied. Green manuring (*Bulletin of the Imperial Institute*, 1906, **4.** 118) is of value, and for this purpose "Sunn Hemp" (*Crotalaria juncea*), "Khesari" (*Lathyrus sativus*), and "Mung" (*Phaseolus Mungo*) are employed in Bengal. The application of the waste jute stems, left after retting, to the soil is to be recommended, as much organic matter can thus be returned to the soil, which would otherwise be wasted.

Connected with the problem of increased area of cultivation is the important one of obtaining an increased yield from areas already under jute. Cake manures, green manuring, and the use of waste stems are likely to prove of value in this direction.

In districts where the cultivation of jute itself is not likely to prove successful on account of the soil or climatic conditions, it seems probable that either "Bimlipitam jute" (*Hibiscus*

cannabinus) or "Sunn Hemp" (*Crotalaria juncea*) may be cultivated. Of these two the former is already largely cultivated, and as it can be grown in most parts of India, and the fibre is only slightly inferior to jute, it seems likely that its cultivation will be extended greatly.

Sunn hemp is extensively grown throughout India as a fodder, a green manure, or for the sake of its fibre. As a fibre plant it possesses several advantages over jute. It can be sown and allowed to grow more thickly; weeds are thus killed and little attention is needed after the plants are a few inches high. It is not so exhaustive to the soil, being a leguminous plant and consequently capable of fixing atmospheric nitrogen, and thus enriching the soil for following crops. The method of preparing the fibre is similar to that used for jute, and the fibre can be used for many of the purposes to which jute is applied as well as being used for sail-cloth and rope manufacture, for which its superior strength and durability give it special advantages.

COTTON GROWING IN ALGERIA.

EXPERIMENTS in the cultivation of cotton in various French Colonies are at present being carried out by "L'Association Cotonnière Coloniale," which was founded in 1903 with a view to encourage cotton cultivation in French Colonies, and ensure an adequate supply of raw material for the cotton industry of France. A general account of the work of this association has been published in the *Bulletin of the Imperial Institute*, 1904, **2**. 122.

The first important experiments in the cultivation of cotton in Algeria were commenced in 1850, and in the Paris Exhibition of 1855 a collection of fabrics was shown, which had been manufactured from cotton grown in Algeria. The French Government afforded much encouragement to the cultivation of cotton, prizes being given for the best plots and also for improved methods of ginning. The best varieties of seed were distributed, and the Government undertook to buy the raw cotton from the cultivators at prices much in advance of those

ruling at the time in the Havre market. In some cases, from three to four shillings per pound was paid for cotton, which could then be procured in the market at half this price. It is stated that the Government subsidies amounted to at least £8 per acre of land under cotton.

As would be expected under these circumstances the planters eagerly took up the cultivation of such a remunerative crop, and in 1855, the province of Oran alone had about 30,000 acres planted with cotton. The following particulars show the production of ginned cotton in Algeria about this time :—

	Lb. of ginned cotton.		Lb. of ginned cotton.
1851 . . .	9,466	1859 . . .	234,238
1853 . . .	188,562	1861 . . .	262,717
1855 . . .	147,338	1863 . . .	860,226
1857 . . .	229,715	1864 . . .	992,406

The large bounties offered by the Government gradually diminished, and when the price obtained for raw cotton reached its normal level, cultivation at once commenced to decline. In 1871, the production was 594,000 lb., but in 1876 the number of planters was reduced to five, and the area under cultivation was not more than 90 acres, from which a crop of 31,900 lb. of ginned cotton was obtained. From this time the cultivation of cotton in Algeria became wholly neglected, it being said that the climate was unsuitable, the temperature too variable, and the price of labour too high.

Recently, mainly through the activity of "L'Association Cotonnière Coloniale," the cultivation of cotton is again being taken up, and experiments have been made at Fougala in the Oued-Rir and at Biskra. Samples produced in the latter district, where 10,000 acres were cultivated, were of very satisfactory quality, the cotton being fine, of long staple, and of good colour.

In the Department of Oran, along the railway to Algiers, the artificially irrigated plains of Sig, Perregaux, and Relizane, are well adapted for further experiments.

An area of about 2½ acres planted recently near Orleansville is said to have yielded 4,620 lb. of seed-cotton, this being equivalent to about 308 lb. of ginned cotton, per acre.

Trials have been made at Bona, in the neighbourhood of

Algiers, in the Mitidja Plain, and it is also proposed to carry out a series of experiments in the Issers Plain, where irrigation will not be necessary.

Cotton of good quality can be produced in Southern Algeria, but some difficulty is anticipated there owing to the ignorance of the natives, and to their antipathy to the introduction of any new crop.

M. Malbot, of the "Ecole Supérieure de Commerce d'Alger," states that the lands suitable for the cultivation of cotton in Algeria may be divided into three groups. *First*, in the neighbourhood of Oran, the plains of Sig, Habra, and Chéliff, where, owing to the suitability of the climate, the cultivation is likely to develop most successfully. *Second*, the basin of the Hodna, a district well adapted for the cultivation of cotton, but where some difficulty is likely to be experienced with regard to transport. *Third*, the plains of Mitidja and Bona and the valley of Soumman; it is thought probable that the climate here will be found specially suited for the cultivation of the fine, long-stapled varieties of cotton.

VARIETIES OF COTTON.

Egyptian, American, and Sea Island cottons have all been used in the recent experiments with some measure of success. In certain districts possessing climatic conditions similar to those of Egypt the experiments point to the likelihood of the successful cultivation of Egyptian cotton. Of the several varieties tried, Yannovitch, Abassi, and Mitafifi have been found the most promising. The Yannovitch variety, which is the most valuable, has been grown with some success in the province of Oran. The Abassi variety, which is the most rapidly maturing, has been successfully cultivated in portions of Mostagenen; Brown Egyptian or Mitafifi cotton has been cultivated here and also in Chéliff; this variety is the hardiest of the Egyptian cottons.

The American cottons experimented with have been somewhat less productive. "Louisiana" and "Mississippi" grow well, but as the cotton produced is of much lower value than the Egyptian cottons it is likely that greater attention will be directed to the cultivation of the latter varieties.

Sea Island cotton was formerly grown experimentally in Oran, but it gave so small a yield compared with other varieties that it was not extensively adopted. During the last two years, however, further attempts have been made to cultivate this variety, and the results obtained have been more promising.

It is likely that the planters will concentrate their efforts upon the cultivation of varieties of Egyptian cotton, particularly Yannovitch and Mitafifi, and it is suggested that by hybridisation, types of cotton may be obtained, suited to the climatic conditions of the country.

METHODS OF CULTIVATION.

M. Malbot has advised the cultivators in Algeria to follow the methods adopted in Egypt, where sowing is completed by the end of March and the cotton is harvested by the end of October. In Algeria, the harvesting is completed a little later, generally by about the middle of November.

The seeds should be disinfected, and prior to planting soaked for at least 48 hours in water to hasten germination. They should be placed in the soil at a depth not exceeding 5 centimetres, eight to ten seeds being placed in each hole. Later, when the young plants have appeared, the two healthiest should be allowed to remain and the rest pulled up. The ground requires to be ploughed and weeded, and the plants should be watered at least ten times during the season, once in April, twice in May, once in June, twice in July, twice in August, once in September, and once in October. The application of either farmyard or chemical manure is recommended.

In addition to the climatic advantage of Algeria as a cotton-growing country, it is fortunate in its close proximity to France, where there is a large market for raw cotton, and in possessing abundant and cheap labour; the cost of transport to the coast is also low. Since cotton-picking commences at a time when other crops have been harvested, there is not likely to be any difficulty with regard to the supply of labour.

Four gins have been installed already at Oran by the Association, and the raw cotton is forwarded there to be ginned.

In 1905, 7,055 lb. of Algerian cotton were sold at Havre, and in 1906, the amount had increased to 27,240 lb. It is anticipated that the area under cultivation will be greatly extended during the present year, and there is every probability of a large increase in the amount of cotton produced.

MANGANESE ORES: THEIR USES, OCCURRENCE AND PRODUCTION.

THE increasing demand for manganese ores and the recent diminution in the output from Russia has led to a largely-increased market for the manganese ores of other countries.

A good deal of new information has been published recently regarding the Indian deposits, and prospecting has been actively carried on in other parts of the world, so that a *résumé* of the information now available may be useful to those interested either in the production or consumption of these ores.

Uses of Manganese Ores.

Over 90 per cent. of the manganese ore produced is utilised in the iron and steel industry, being smelted to form an alloy with iron, which is added to certain classes of steel in the final stage of manufacture of the latter.

The amount of manganese in the iron-manganese alloys used in this way varies from 2 to 80 per cent., those containing up to 20 per cent. being known as spiegeleisen, whilst the name ferromanganese is reserved for those whose manganese content exceeds this. These alloys are added in the production of steel by the Bessemer and open hearth processes to prevent oxidation of the iron, to remove the small quantities of silicate and oxide of iron, and to facilitate combination of the carbon and iron. As a result of these various effects the steel is rendered more valuable. The amount of manganese consumed per ton of steel produced is approximately for open hearth steel 13·5, mild Bessemer steel 16·5, and Bessemer steel for rails 29·0

pounds per ton. Manganese-iron alloys are also used in the manufacture of special manganese tool steels of high tensile strength and hardness, and of the chilled cast-iron of unusual toughness, employed for the wheels of railway wagons.

Manganese forms an ingredient in other valuable alloys. Copper containing about six per cent. of manganese is extremely fire-resistant, and is employed in the manufacture of locomotive fire-boxes. About two per cent. of manganese may be added with advantage to nickel-copper alloys for coinage. The same percentage is used in nickel castings, an excess having no detrimental effect, as is the case with magnesium, which has been employed in the same manner.

The higher oxides of manganese were at one time largely employed in the production of chlorine and bromine, the former being a step in the manufacture of bleaching-powder, but now that the manganous bye-product can be oxidised and used again, the consumption for this purpose is comparatively small.

The salts of the manganates and permanganates are employed on account of their oxidising powers for disinfecting purposes, as driers of oil varnishes and in other ways, while the natural ores, rich in oxygen, are used to decolourise greenish glass by converting ferrous into ferric oxide. In larger amounts they impart to glass and pottery a fine purple colour, and inferior qualities of ore are used in the United States for colouring bricks. Manganates and permanganates are also employed for calico printing and dyeing, as well as in the preparation of green and purple pigments. Certain varieties of rhodonite are capable of taking a high polish and have occasionally been used as ornamental stones. They are liable, however, to lose their colour on exposure to light. The non-metallurgical applications of manganese do not absorb more than a small percentage of the total output.

Varieties of Ore.

Manganese ores are widely distributed, but they vary in composition, and many deposits are not worth working at the present time.

The principal manganese ores of commercial importance are the oxides. These may be classified according to the amount of oxygen they contain and the presence or absence of water. The most highly-oxidised ores are the dioxides (MnO_2), viz. polianite and pyrolusite, which are anhydrous, and psilomelane and wad, which contain water. They are black in colour and in most cases yield black streaks. Polianite has a hardness of 6 to 6½ on the usual scale, and crystallises in the tetragonal system. Pyrolusite has a hardness of only 2 to 2½ and colours the fingers black. It is often impure, containing iron, silica, lime, baryta, and other extraneous material, with in many cases a little water. It has no crystalline form of its own, but occurs in pseudomorphs after manganite. Psilomelane is found in rounded or botryoidal masses, usually with a smooth surface. It has a hardness of from 5 to 6, and contains a considerable amount of water. The colour is black, but the streak is brownish-black, a certain proportion of lower oxide being present. Wad or bog manganese contains still more water, and is soft and friable. The sesquioxide (Mn_2O_3) appears in the anhydrous state in braunite, a tetragonal mineral, which crystallises in pyramids resembling regular octahedra. It contains about eight per cent. of silica, and is sometimes described as a silicate. It has a hardness of 6 to 6½, and is brownish-black in colour and streak. Manganite is the hydrated form. It crystallises in prisms belonging to the orthorhombic system, and has a hardness of 5 to 5½. It is usually brown or brownish-black in colour and streak. Hausmannite (Mn_3O_4) has still less oxygen, and crystallises in tetragonal pyramids similar to those of braunite. It has a hardness of 5 to 5½, and is brownish-black in colour, that of the streak being chestnut brown.

Pyrolusite and wad can be distinguished at once by their comparative softness (less than that of fluorspar or even calcite) and the lightness and incoherence of the latter. On heating wad in a glass tube closed at one end, water is given off and is deposited higher up on the glass. Psilomelane and manganite also give water; they can be easily distinguished from one another by their appearance. Braunite and polianite give off no water. They may be distinguished by the brownish or

brownish-black streak of the former, that of the latter being black.

Among less important ores are the pinkish carbonate and silicate, dialogite and rhodonite ; and franklinite, which is composed of the oxides of zinc, iron, and manganese, and resembles magnetite in appearance. Franklinite is employed, after the extraction of the zinc, in the preparation of the manganese-iron alloy known as spiegeleisen. Manganiferous iron ores in general have a higher value than those which do not contain manganese.

As the value of manganese ore formerly depended on the amount of oxygen present in excess of that in the monoxide, only the dioxides were considered worth working. At the present time the content of manganese is of more importance, and for this reason, other things being equal, the lower oxides are more valuable. The ore is, however, liable to be seriously depreciated by the presence of silica or of even small amounts of phosphorus.

The value of manganese ore is quoted at so much per ton for each unit per cent. of the metal present, but if the percentage falls below the standard, which in the United Kingdom is fixed at fifty per cent., the price per unit is diminished by about a $\frac{1}{4}$*d.* for every unit per cent. of the deficiency. There is not much demand for ores containing less than forty per cent. of manganese, unless they come into the category of manganiferous iron ores, which are outside the scope of the present article.

In 1900 the price per unit for standard ore reached 15 pence, it fell to 10 pence in 1904, but has now risen to 14 pence. Deductions are made for the phosphorus and silica present.

In the United States the standard is forty-nine per cent., and 1 cent. per unit is deducted for each 0·02 per cent. of phosphorus in excess of 0·1 per cent., and 15 cents. per ton for each per cent. of silica in excess of 8 per cent. On the other hand an addition of 6 cents. is made to the price per ton for each unit per cent. of iron present. In the case of manganese ore the long ton of 2,240 lb. is still retained in the United States.

The percentages of the principal constituents of some of the manganese ores of commerce are shown in the following table:—

Origin of Ore.	Manganese. Mn Per cent.	Iron. Fe Per cent.	Silica. SiO_2 Per cent.	Phosphorus. P Per cent.
Russia.				
Caucasus, high grade .	52·20	0·41	5·22	0·13
Caucasus, low grade .	45·50	—	7·38	0·48
Ekaterinenberg . .	53·70	0·86	8·10	trace
Brazil.				
Average of shipments to the United Kingdom, 1900 . .	53·35	—	1·02	0·03
India.				
Gosalpur . . .	54·29	1·41	3·27	0·16
Spain.				
Huelva carbonate ore .	41·15	0·77	14·10	—
Greece.				
Milos, average . .	34·73	3·00	22·92	0·06
Japan.				
Average . . .	48·86	—	10·40	0·08
United States.				
Virginia, Crimora mine	57·29	0·37	—	0·08

The consumption of manganese ores by the countries, which utilise the greatest amount in their manufactures, for the last three years for which figures are available is shown in the following table:—

	1903. *Tons.*	1904. *Tons.*	1905. *Tons.*
Germany . . .	260,568	303,110	309,658
United Kingdom .	232,682	213,931	253,174
United States . .	148,881	111,665	261,146

In the case of the United States these totals do not include manganiferous iron and zinc ores.

The amounts in metric tons and values of the manganese ores mined in the chief producing countries are shown in the following table:—

	1903.		1904.		1905.	
	Metric Tons.	Value. £	Metric Tons.	Value. £	Metric Tons.	Value. £
Australia	1,425	5,605	843	3,540	1,541	5,925
Austria	6,179	—	10,189	—	13,788	—
Belgium	6,100	3,141	485	174	—	—
Brazil[1]	161,926	248,010	208,260	306,799	224,377	332,827
Canada[1]	82	570	112	556	20	353
Chile	17,110	—	2,324	—	1,324	—
Cuba	21,070	24,771	17,683	18,269	12,133	12,230
France	11,583	11,676	11,254	11,189	6,751	7,949
Germany[2]	47,994	25,458	52,886	28,934	51,463	29,277
Greece	9,340	11,204	8,549	5,147	8,171	4,861
United Kingdom[2]	831	656	8,897	4,370	14,706	11,634
Italy	1,930	2,327	2,836	3,438	5,384	5,869
India	174,562	151,530	152,707	129,632	257,970	248,309
Japan	5,616	3,828	4,324	3,604	11,162	8,546
New Zealand	71	210	199	570	56	165
Russia[1]	458,948	618,906	485,228	660,638	357,796	467,263
Spain	26,194	18,183	18,732	5,237	26,020	7,475
Sweden	2,576	2,376	2,471	2,475	2,150	2,153
United States[2]	2,870	5,693	3,197	6,040	4,184	8,239

[1] Exports only. [2] Value at mines.

These amounts are exclusive of manganiferous iron and zinc ores. In 1906 the output of manganese ore for India was nearly half a million metric tons.

OCCURRENCE OF MANGANESE ORES.

United Kingdom.

The production of manganese ore is low and very variable; the more important deposits occur in Carnarvon, Merioneth, Devon, Cornwall, and Shropshire.

Carnarvon.—The bulk of the ore produced in the United Kingdom is obtained from this county, the production in 1904 being 8,756 tons, and in 1905 14,286 tons. The ore occurs at Rhiw in old volcanic rocks, and carries 33 per cent. of manganese and 10 per cent. of iron.

Merioneth.—The principal producing centres are Barmouth and Llanbedr. The ore, which consists of silicate and carbonate, averages 27 per cent. of manganese, and occurs in beds about 2 feet thick intercalated between the grits and slates of the Lower Cambrian formation.

Devon.—Good quality ore is found in various parts of the county, and has been worked at Newton, St. Cyres, and at other places in the neighbourhood of Exeter. It occurs as an infilling

in the basement beds of the New Red Sandstones, which are probably of Permian age.

Austria.

The industry is of small importance; the chief producing centres are Bukowina and Krain. The ore produced in the latter locality is smelted at Servola. Deposits also occur in Carniola, Bohemia, and Istria.

France.

The chief occurrences of manganese ore are the Las Cabesses mine near Rimont in Ariège, the Romanèche and Grand Filon mines in the department of Saône et Loire, Corbières near Cannes and Ville Aure, Dessus. The deposits of Las Cabesses formerly produced large amounts of carbonate ore, but they have not been worked since 1904. The chief producers at the present time are Romanèche and Grand Filon, which yield pyrolusite.

Germany.

Almost the entire German production of manganese ore is obtained from the neighbourhood of Coblenz. The principal mines are the consolidated Schlossberg, Amalienshöhe, Concordia and Elisenhöhe. The ore usually occurs in pockets.

Greece.

The annual output of manganese ore showed a remarkable development in 1903, which bids fair to be maintained. Important deposits are situated on the islands of Milos and Andros. The quantity of pure manganese ore mined is small, but a large amount of manganiferous iron ore is obtained from these and other localities.

Italy.

Deposits of ore occur in Liguria, Tuscany, and elsewhere, but the output is small owing to the high percentage of silica in the ore and the lack of transport facilities. A certain amount of manganiferous iron ore is also produced.

Russia.

Nearly one-half of the world's output of manganese ore is obtained from Russia; the chief producing areas are the

Caucasus, South Russia, and to a less degree the Urals. In these districts there are ample reserves of ore, sufficient to enable Russia to maintain for a long time to come an important position as a producer of high-grade ore.

The development of the industry is hampered by the lack of transport facilities, which prevents the opening up of new deposits, and also by the high rail charges to the port of shipment. The methods of mining employed are primitive, and as there are no professional miners occasional labour only is employed. There is also a lack of organisation among the producers.

Caucasus.—One of the most important deposits of this district is situated at Chiaturi. The mode of occurrence and method of mining are typical of the other Russian deposits. The manganese extends over an area of 30,000 acres, in a bed about 6 to 7 feet thick lying almost horizontally and consisting of pyrolusite and other oxides of manganese together with a certain amount of sandy calcareous matter. The ore is not submitted to any mechanical cleaning process, but is hand-picked and classified as "very rich," "rich," and "medium," and by this process yields about 33 per cent. suitable for shipment. The ore has to be transported 1 to 6 kilometres in mine trucks, 40 kilometres by narrow-gauge railway, and then reloaded into broad-gauge wagons and conveyed 131 kilometres to Poti, where it is shipped.

South Russia.—The principal deposits are situated in the Nikopol district in the government of Ekaterinoslav. The ore consists of pyrolusite in lumps, and as exported averages 46 per cent. manganese, 12 per cent. silica, 0·25 per cent. phosphorus, and 1 per cent. iron.

The crude ore is screened and separated into two classes, according to size, (A) above 0·5 inch in diameter, (B) below 0·5 inch in diameter. The adhering clay or foreign matter in class A is removed with hammers, and the residue, which amounts to about 12 per cent. of the crude ore and contains 48 per cent. of manganese, is known as "large ore." Class B is screened and yields two classes, (C) above 0·16 inch in diameter, (D) below 0·16 inch in diameter. Class C is hand picked, averages about 12 per cent. of the crude ore and contains 41–42 per cent. manganese. Class D, amounting to 75 per

cent. of the crude ore, carrying 50 per cent. of the total manganese, is waste.

Processes for dressing the ore other than that described above are little used, as the principal consumers, the blast-furnace owners, prefer a high-grade lump ore to a small-sized, dressed product. An example of what can be accomplished by dressing is furnished by the case of an ore very rich in silica, which was experimentally treated at the Nora works in Witten (Germany). As mined it contained 15 to 20 per cent. of manganese and a large percentage of silica. By thoroughly crushing the ore and concentrating the grains by jiggers, and the slimes on shaking tables, products were obtained amounting to over 40 per cent. of the original material and containing from 44 to 50 per cent. of manganese. A simple and cheap process of briquetting the pulverulent dressed product would doubtless aid the development of the dressing of manganese ore.

Spain.

In past times considerable quantities of manganese ore have been exported from Spain, but during recent years the production has steadily diminished.

The chief deposits hitherto worked are situated in the province of Huelva, but they are now to a large extent exhausted. Several new deposits have been located in the province of Teruel, where the ore is of the silicate variety and contains 33 per cent. of manganese, and 30 to 37 per cent. of silica. It is exported to Belgium and Luxemburg, and smelted with aluminous iron ores. Manganese also occurs in the provinces of Cuidad Real and Oviedo. A large quantity of manganiferous iron ore is also exported from Spain.

Sweden.

The output of pure ore is small; the chief producing districts are Undenäs (Bölet), West Gothland, Wermland, and Jonkopings.

Turkey.

The principal output in European Turkey is from the Kassandra mines in the province of Salonika, which yield about

60,000 tons of pyrolusite ore annually. A similar amount is obtained from deposits in the Phlinika district, Asia Minor, which yield an ore containing 52 per cent. of manganese. Small quantities of ore are also obtained from the provinces of Trebizond and Aidin.

Cape Colony.

Manganese ore occurs near Constantia Nek and in the Klein Drakenstein Mountains near Paarl, in the neighbourhood of the main line railway, less than 40 miles from Cape Town. Specimens from this locality analysed recently in the Scientific and Technical Department of the Imperial Institute showed 57·41 and 51·93 per cent. respectively of metallic manganese, 1·14 and 4·96 per cent. of silica, and 0·51 and 0·75 per cent. of phosphorus. The amount of phosphorus is high, and would seriously affect the value of the ore, which, moreover, does not appear to occur in any very large amount.

St. Helena.

Recent investigations at the Imperial Institute of samples from the deposits of manganese ore on this island have shown that the ore would require concentration before export. The deposits require further investigation.

Canada.

The small production of manganese ore is not due to absence of suitable deposits, but to lack of facilities for readily disposing of it. The recent development of the Canadian iron and steel industry will no doubt cause an increased production of this ore.

The chief deposits are situated in Nova Scotia and New Brunswick.

Nova Scotia.—The only ore mined to any extent is pyrolusite, which occurs in Carboniferous and older strata.

The most important outcrop in *Cape Breton County* is situated at the headwaters of the Salmon river. The ore occurs, in irregular bedded layers, varying in thickness up to 18 feet, in soft arenaceous shale. It is stated to be suitable for chemical purposes, being free from iron and other impurities. In *Hants County* important deposits occur in a belt of limestone, 300

feet thick, which lies at the base of the Carboniferous formation and extends for a distance of 40 miles from the shore of Minas Basin to the estuary of the Avon. The best-known deposits, the Tenny Cape mines, have been worked since 1861. The ore is pyrolusite, of very high quality, and occurs in a twisted brecciated dolomite in veins, nodules, and masses. At *Minasville*, four miles from the Tenny Cape mines, manganese ore occurs in the Devonian quartzites, which underlie the limestone. Small quantities of ore have been shipped from this deposit.

In *Colchester County* manganese is found at East Onslow, where the ore consists of pyrolusite with occasional manganite and psilomelane and occurs in the joints and bedding planes of the old Devonian quartzites. The deposits, which in some places attain a thickness of about a foot, have been worked intermittently since 1887. The iron ores of Londonderry contain manganese up to a maximum of 14 per cent.

The most promising deposits in *Lunenburg County* are those of New Ross, from which several hundred tons of ore have been exported. The ore, which is a mixture of psilomelane and manganite, occurs in veins, which vary in thickness from 4 to 40 feet. Manganese is known to exist in numerous other localities in the province.

New Brunswick.—The most important deposits lie in *King's County* at Markhamville. The ore is found either as pyrolusite and manganite showing crystal forms, or in nodules. It occurs in beds of varying thickness or in irregular pockets, one of which is said to have yielded 3,000 tons of ore. The surface of the limestone in which the deposits occur is much decomposed, leaving a residue of clay, which varies from 8 to 20 feet in thickness and often contains deposits of manganese ore, which can be cheaply worked. The better-class ores are prepared for the market by crushing and sizing with screens. They are used mostly for chemical purposes, but low-grade ores are shipped without dressing for the production of spiegeleisen. *St. John's County* has a deposit at Quaco Head, on the north shore of the Bay of Fundy. The ore, which was worked for some time, occurs in the Lower Carboniferous limestone and consists chiefly of pyrolusite.

In *Albert County* mines were opened at Shepody Mountain in 1860, and the ore, consisting of psilomelane and pyrolusite, obtained by means of a tunnel driven into the side of the mountain for a distance of about 1,000 feet. An important deposit of wad in this county occurs at Dawson Settlement, immediately below the turf, and averages 6 feet in thickness. It is dried in revolving cylindrical furnaces and then briquetted and shipped to Bridgeville, where it is smelted.

Quebec.—The only occurrences of crystalline manganese ore which have been observed in Quebec are those of the Magdalen Islands in the Gulf of St. Lawrence. Wad has been noted in many localities, but the quality is usually low. In the Ungava territory, and especially in the Nestapoca chain of islands, spathic iron ore rich in manganese carbonate has been found. An average ore from Flint Island yielded 25 per cent. of iron and 24 yer cent. of manganese carbonate. These deposits are very accessible, and should permit of profitable working.

Ontario possesses few manganese deposits, and none of them have been worked. Manganite occurs in veins at Bachewanung Bay, and also in the Rainy Lake district. Wad has been located in several places, an extensive deposit occurring in Hastings County.

British Columbia possesses few manganese deposits so far as is known. Wad is recorded in the Nicola Valley.

Analyses of Canadian Manganese ores.

	Manganese dioxide. MnO_2.	Total manganese. Mn.	Ferric oxide. Fe_2O_3.	Silica. SiO_2.	Phosphorus. P.	Nature of ore.
Morrison Mine, Loch Lomond, Cape Breton Co.	91·84	—	0·12	2·91 [1]	—	Pyrolusite
Boularderie Island, Cape Breton Co.	44·33	—	35·50	10·00 [1]	—	Wad
Londonderry, Colchester Co.	67·10	—	—	4·08	—	—
Tenny Cape, Hants Co.	85·54	—	1·18	3·27 [1]	0·34	—
Cheverie, Hants Co.	90·15	56·97	2·55	2·80 [1]	0·45	Pyrolusite
Springville, Pictou Co.	14·41	9·10	48·22		0·02	—
Dawson Settlement, Albert Co.	—	45·81	13·65	5·36	0·05	—
Markhamville, King's Co.	97·25	—	0·85	—	—	Pyrolusite
Quaco Head, St. John's Co.	71·54	58·20	2·19	8·37 [1]	0·02	,,

[1] Silica and Insoluble matter.

United States.

Manganese ores carrying over 50 per cent. of the metal are only produced in small quantity, and those chiefly from the Crimora mine in Augusta Co., Virginia. Smaller amounts are obtained from California and Utah. Manganiferous iron ores carrying up to 30 per cent. of the metal are mined in Colorado, Michigan, Wisconsin, and Arkansas. The production in 1905 of this class of ore amounted to 769,256 tons, valued at the mines at £323,951. In the same year 90,289 tons of a manganese-bearing by-product was obtained in the course of extraction of zinc from franklinite. In Colorado a manganiferous and argentiferous iron ore is mined. It does not carry sufficient silver to pay for direct extraction, and it is either sold to the silver-lead smelters as a flux or employed in the manufacture of spiegeleisen. The quantity produced in 1905 amounted to 81,278 tons, valued at 13*s.* 8*d.* per ton.

Cuba.

A considerable amount of manganese has been produced in Cuba in recent years. The low freight gives it appreciable advantage in the United States market, and in spite of the fact that the principal producing company ceased operations in October 1905, there is probably a future for this industry. The deposits on the south coast in the San Maestro range extend over a distance of 100 miles, and there are 88 mines in the province of Santiago de Cuba.

St. Thomas Island, West Indies.

In 1896 it was reported that a deposit of manganese ore of good quality and considerable extent had been located on St. Thomas Island, but no ore seems to have been exported.

Colombia and Panama.

These deposits have been worked to a considerable extent of late years, the principal exports being made from Panama.

The ore-yielding region is situated on the Carribean coast and extends from Puerto-Bello in an easterly direction for 35 miles towards Point-San-Blas. The most important mine is the

Soledad, which is situated 35 miles south-east of Nombre de Dios, and supplies two-thirds of the ore exported from this region.

The ore, which consists chiefly of psilomelane, together with braunite and pyrolusite, occurs in irregular lenticular masses, varying in size from a few inches up to 50 feet, in a decomposed shale.

The ore is broken in the mine by means of machine drills, hand picked, washed, and screened. The larger sizes are exported, but ore averaging less than half-a-millimetre is reserved for concentration. The ore exported generally contains 57·8 per cent. manganese, 4·18 per cent. silica, 2·73 per cent. water, and 0·06 per cent. of phosphorus.

Brazil.

The manganese industry, which is of comparatively recent origin, is rapidly increasing in magnitude. Many of the deposits are situated at a considerable distance from the coast, but they can be profitably worked on account of the high grade of the ore.

The most important deposits occur in the states of Minas Geraes, Matto Grosso, and Bahia. They fall into two classes: (1) those associated with deposits of iron ore, and in some cases limestone; (2) those occurring in gneissic rocks.

To the former class belong the deposits near Miguel Burnier and Ouro Preto in Minas Geraes, and those near Curumbá in Matto Grosso.

The Miguel Burnier deposits are worked partly in open workings and partly by levels. They contain 55 per cent. of manganese and are fairly free from phosphorus, but a large amount of moisture is present.

Experiments have been made in roasting the ore before shipment, in order to economise freight, but they had to be temporarily abandoned as the ore became very friable after this treatment. Later reports state that a briquetting process has been successfully employed in the Ouro Preto district. The binding material is stated to be the moisture remaining after reducing the ore to 1·5 mm. The presses work at a pressure of 10 tons per square inch, and turn out 100 tons of briquettes

per day. The briquettes weigh $1\frac{3}{4}$ lb., and are said to resist shock and a high temperature without disintegrating.

Manganese ore associated with gneiss is found near Queluz (Lafayette) in Minas Geraes and Nazareth in Bahia. It occurs in the form of veins, dykes or lenticular masses, which usually dip at a considerable angle. The ore from the mines at Nazareth contains about 47 per cent. of metallic manganese, 7·2 per cent. of silica, 0·38 per cent. of phosphorus, and from 1·5 to 1·75 per cent. of moisture.

Chile.

The deposits at present exploited are not extensive. The best-known mines are situated at Coquimbo and Atacama. The ore exported averages 50 per cent. of manganese, 10 per cent. of silica, and 0·1 per cent. of phosphorus.

Australia.

Queensland.—The total production of manganese ore is small. It is taken by the Mount Morgan gold mine and utilised for the chlorination process. The ore is obtained almost entirely from the Gladstone district, where it occurs in altered sedimentary rocks, intersected by igneous dykes, and supposed to be of Permo-carboniferous age.

The deposits are usually lenticular, with their longer axes parallel to the cleavage of the rocks, running from north to south. Gladstone is situated on a band extending northwards through the islands of Port Curtis and southwards to Biondello. The most important producing mine is the Mount Miller, discovered about eight years ago. The workings are situated near the summit of the hill, 400 feet above the Calliope river. The ore body varies from 3 to 20 feet in thickness and consists of psilomelane and pyrolusite. The best ore occurs where the country rock is softest, and so far as has been found at present the latter decreases in hardness with the depth. The ore after being broken is hand picked.

Deposits have also been worked in the same district at Auckland Hill. Small quantities of ore, averaging 65 per cent. of manganese dioxide, have occasionally been shipped from the Rockhampton district. Deposits of manganese ore have been

located, and in some cases worked for a time, in the Bundaberg, Warwick, Gin-gin, and Ipswich districts. In the latter locality the outcrop extends over an area of six square miles.

New South Wales.—Ores of manganese occur in considerable quantities in different localities and formations, but they are situated at a considerable distance from the coast, and the cost of land transport in addition to that of the freight to Europe has hitherto prevented their exploitation. When the time comes for the development of an iron and steel industry in Australia, the question of the extent and character of the manganese deposits of New South Wales as well as of the other states of the Commonwealth will become of practical importance, and there can be little doubt that there will prove to be an ample supply of ore for local needs.

Victoria.—Manganese and manganiferous iron ores occur in large masses in Eastern Gippsland.

Tasmania.—Large deposits of manganese ore occur at Zeehan in the west of the island.

New Zealand.

Manganese ore occurs in fair quantity in North and South islands, but the production is very low, there being no home market despite the offer of a bonus for manufacture within the Dominion and export to a foreign market of speigeleisen or manganese bronze. Since 1878 over 19,000 tons of ore, valued at £61,000, have been exported.

The ore occurs at Bay of Islands and Whangerei, Auckland; Ohariu, Wellington; Napier, Hawke's Bay; Malvern Hills, Canterbury; and Taieri Mouth, Otago. The ore from the last-mentioned locality shows over 90 per cent. of manganese dioxide.

Philippines.

Manganese ore is found in the Province of Ilocos Norte, in the north-west of Luzon. The most promising deposits are close to the coast, to the east of Punta Negra. The ore contains nearly 49 per cent. of metallic manganese, about 10·5 per cent. of water, only 1 per cent. of silica, and 0·02 per cent. of phosphorus, but there is some doubt as to the downward extension of the deposit.

Japan.

There are manganese mines at Setanai, Aza Toshibetsu, Fukama, Twasaki, Searaschi, and Saba. The ores exported are of fairly high grade and average 52 per cent. of manganese and 0·8 to 0·16 of phosphorus.

British North Borneo.

These recently-discovered deposits have been already noticed in this *Bulletin* (1906, **4**. 69, 309).

The deposits occur close to Tarritipan near the southern end of Marudu Bay. It has been estimated that an annual output of 40,000 tons could be maintained easily.

Java.

Deposits of ore occur and have been worked in the Regencies of Pengasih and Nanggolau. The production is variable up to 500 tons per annum. Occasional shipments have been made to the Mount Morgan gold mines, Queensland. In 1905, 1,600 tons were exported from Djokjoharta.

India.

The mining of manganese ore in India is a comparatively new industry, having been only commenced some fifteen years ago. Operations were first carried on in the Vizianagram State close to the Bay of Bengal in the north of the Madras Presidency, but the greater portion of the output is now obtained from an extensive series of deposits in the Central Provinces and Central India, especially in the Nagpur, Bhandara, Balaghat, Chhindwara, and Jabalpur districts, as well as the Gwalior, Khairagarh, and Kalahandi States.

In most of these localities the ore occurs as lenticular masses and bands in quartzites, schists, and gneisses, and is supposed to be formed by the decomposition of manganiferous garnets. The ore bodies, which are sometimes several miles in length, consist of a mixture of braunite and psilomelane. The ore exported contains over 50 per cent. of metallic manganese.

The cost of transport is considerable, and renders the working of any but the highest grade ore almost impossible ; the charges

to Bombay (about 500 miles) being 9*s.* 6*d.* per ton, and to Calcutta (700 miles) 13*s.* per ton.

As the Vizianagram deposits are near the coast a lower grade of ore can be mined at a profit, so that the percentage of manganese in the material exported ranges from 45 to 50 per cent. only.

The manganese ore of the Jabalpur district is found in quartzites, phyllites, and schists of the Dharwar type, which include slightly manganiferous hæmatite, often capped by limonite with irregular nodules of psilomelane. The ore also occurs in cavities. Deposits of manganese ore are met with under similar circumstances in the Panch Mahals in the north, and Dharwar in the south of the Bombay Presidency, and in the Sandur Hills, Madras.

Manganese ore occurs in laterite at Belgaum and Satara in the Bombay Presidency, as well as at Jabalpur. The proximity of the Belgaum deposits to the port of Goa should facilitate their exploitation. The recently-discovered deposits in Mysore are also said to occur in laterite.

All the workings are superficial, and might well be classed as quarries. While some deposits are situated in small hills permitting the use of aërial transport gear, others are practically on a level with the surrounding country.

In either case the work of quarrying the ore is mostly performed by hand, the rock being hand-drilled and blasted, or the ore dug out with crowbars. The large blocks thus detached are broken up and the fragments carried out of the quarry by women and children. The ore is cleaned by old men and women with hammers, and then stacked ready for sampling and conveyance to the port of shipment.

Central Provinces.—The principal occurrences in the Central Provinces are in the Ramtek Tahsil of the Nagpur state, where quarrying is carried on in about seventeen villages. The ore exported has the following average composition :—

		Per cent.
Manganese	Mn	51–54
Iron	Fe	5–8
Silica	SiO_2	5–9
Phosphorus	P	0·05–0·12

The deposits in the Sausar Tahsil of the Chhindwara district have been examined by Mr. L. L. Fermor of the Geological Survey of India, and representative samples of the ores have been examined in the Scientific and Technical Department of the Imperial Institute. Some of the results obtained are given in the following table, the names being arranged geographically from north to south:—

		Kachi Dhana.	Lakhanwara.	Gaimukh.	Sitapar.	Gowari Warhona.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Manganese	Mn	54·73	50·41	54·98	54·97	53·59
Iron .	Fe	5·00	11·77	6·19	6·89	5·00
Silica .	SiO_2	6·99	4·86	10·63	6·95	6·21
Phosphorus	P	0·07	0·20	0·04	0·06	0·07
Moisture	H_2O	0·17	0·39	0·32	0·00	0·31

Kachi Dhana.—This is stated to be the most important deposit of the district. It consists of five ore mounds, the largest of which measures 360 yards by 130 yards by 40 feet high, and as far as can be judged the ore body will be from 50 to 100 feet wide.

Gowari Warhona.—A series of trial pits opened up during 1903 showed a good ore stratum 5 to 6 feet thick, dipping 50° to the south, 30° west. About a quarter of a mile of merchantable ore is exposed.

Sitapar.—The deposit occurs in the form of a hillock 23 yards long, 20 yards broad, and 25 feet high, situated in the middle of a field; it will probably be found to be more extensive on removing the surrounding alluvium.

Gaimukh.—This ore occurs as an outcrop 50 yards long and 21 yards broad, and consists chiefly of braunite, with some dialogite. Only the centre of the outcrop, about 20 yards long by 7 yards broad, is suitable as a source of ore.

Lakhanwara.—This is situated about 250 yards west of the Gaimukh ore body. The ore, which is only visible on the surface as three small outcrops, consists of hard grey crystalline braunite.

None of these deposits have yet been worked. This is probably due to the fact that they are distant some 50 miles from the nearest railway.

Mysore.—A new deposit, discovered in August 1905, has

recently been opened up about 20 miles north-west of Shimoga station on the South Mahratta Railway.

The ore occurs in nodules and boulders cemented together by a kind of laterite clay, and varying in size up to several tons. It is shipped in three grades of the following average composition:—

		1. *Per cent.*	2. *Per cent.*	3. *Per cent.*
Manganese .	Mn .	53·72	43·29	32·76
Iron . . .	Fe .	5·55	11·79	14·28
Silica . . .	SiO_2 .	—	*about* 1 *per cent.*	—
Phosphorus .	P .	—	„ 0·05 „	—

The cost of transport to the port of shipment averages 16*s.* per ton. A well-defined lode of high-grade ore has also been opened up and is being exported at the rate of 5,000 tons per month. This ore averages (after drying), manganese 55·69 per cent., 2·98 per cent. of iron, 0·53 per cent. of silica, and 0·015 per cent. of phosphorus.

The following table shows the output in statute tons from different parts of India during the last nine years:—

Year.	Madras. *Tons.*	Central Provinces. *Tons.*	Central India. *Tons.*	Bombay. *Tons.*	Total. *Tons.*
1898 .	60,449	—	—	—	60,449
1899 .	87,126	—	—	—	87,126
1900 .	92,458	35,356	—	—	127,814
1901 .	76,463	44,428	—	—	120,891
1902 .	68,171	89,609	—	—	157,780
1903 .	63,452	101,554	6,800	—	171,806
1904 .	53,699	85,034	11,564	—	150,297
1905 .	63,695	159,950	30,251	40	253,936
1906 .	117,380	320,759	50,073	7,514	495,729

The Indian output now exceeds that of any other country in the world.

The following references may be given to the more important publications on the subject of manganese ores.

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FUEL RESOURCES OF CANADA.

THE considerable extension of smelting and manufacturing industries which has taken place in recent years in various parts of the Dominion of Canada lends special interest to the question of the supplies and nature of the fuel available in the country. There is a considerable amount of information on this subject given in the bulletins published by the Canadian Geological Survey, and in the reports issued by the various Departments of Mines, but it is not always readily accessible, and consequently the paper by Dr. Ells, entitled "Notes on the Mineral Fuel Supply of Canada," which was read before the Royal Society of Canada last year, and has now been issued in

pamphlet form, will prove useful to those interested in this subject. The following summary of the varieties of fuel available, and their distribution in the Dominion, is taken mainly from Dr. Ells' pamphlet, supplemented by information taken from various Canadian geological and mining publications.

VARIETIES.

It is noteworthy that practically all varieties of mineral fuel occur in Canada, and at many different geological horizons.

Anthraxolite.—This substance occurs in small quantities in the form of veins among the pre-Cambrian and early Palæozoic rocks of Quebec and Ontario. Although it has been used as a fuel to a limited extent, it cannot be considered as a settled source of supply, and is of interest from a geological rather than from an economic standpoint. It may be mentioned that anthraxolite closely resembles anthracite in chemical composition and mode of combustion, though it may have a different origin, so that there seems to be little real ground for giving it the special name anthraxolite, or for the assertion made by Dr. Ells that "anthraxolite is more closely related to rock oils or petroleums than to true coals."

Anthracite.—Deposits of a good quality of this variety of coal occur along the eastern slopes of the Rocky Mountains in the southern part of British Columbia, and also in other parts of Western Canada, where Cretaceous and Tertiary lignites have undergone metamorphism. It also occurs among the Devonian shales at Lepreau basin in the southern part of New Brunswick, but here it is of little or no economic value.

Bituminous coal.—This variety occurs among the Carboniferous rocks of Eastern Canada, in Nova Scotia, and New Brunswick, where it has long been mined. Further, many of the metamorphosed lignites of Western Canada really belong to the bituminous type.

Lignite.—This, with the bituminous and anthracite varieties which have resulted from its alteration by earth movements, constitutes by far the most important of Canada's fuel resources. It occurs in almost inexhaustible deposits among the Cretaceous and Tertiary rocks of Western Canada, on both sides of the

Rocky Mountains, and at practically all latitudes, from the United States border on the south to the Yukon and Mackenzie territories on the north.

Peat.—This occurs in large quantities in Ontario, Quebec, and Manitoba, and in some places a successful industry in the manufacture of compressed peat fuel is being carried on. In all three provinces the prospects for the development of the industry are good, as peat is abundant and accessible.

Mineral oils.—These occur in various parts of Ontario and New Brunswick, and in the latter province bitumen also occurs. For more detailed information regarding the extent of the petroleum industry in Canada see this *Bulletin* (1903, **1.** 93, 183; 1904, **2.** 115, 116).

DISTRIBUTION.

The fuel resources of Eastern Canada, with the exception of the peat deposits, are practically limited to the Carboniferous areas of Nova Scotia and New Brunswick, while in Western Canada they are almost completely confined to rocks of Cretaceous and Tertiary age.

Eastern Canada.

Nova Scotia.—Here the important localities are Sydney, Richmond, and Inverness in Cape Breton; and Pictou, Springhill, and Joggins in Nova Scotia proper. The Sydney coalfield is the most important. Oil shales (stellarite) are associated with the bituminous coals in Pictou County. No coal occurs in the southern half of Nova Scotia, which is occupied by gneiss and metamorphic rocks.

Prince Edward Island.—No coal outcrops at the surface anywhere in this island. The rocks at the surface are either upper Carboniferous or Permian, and may be underlaid by coal measures, though probably at considerable depth. Excellent peat is found in the island, but this has not yet been exploited, as coal can be carried cheaply across the Northumberland Straits from Pictou and Inverness.

New Brunswick.—In this province the Carboniferous rocks cover an area of more than 10,000 square miles, but coal is not

so abundant as might be expected. The most important locality is near the upper end of Grand Lake, where the main seam in some places attains a thickness ot two and a half feet. Elsewhere the seams are usually thin.

The Devonian shales of this province are occasionally coal-bearing, but these occurrences are not of economic importance. More important are the Devonian shales of Albert County, which carry oils and bitumen. Some of the shale bands are rich in oil (carrying from 30 to 80 gallons per ton), and are richer than the oil shales which have been extensively mined in Scotland. These shales were formerly worked for oil with some success, but they were unable to compete with the cheaper native oils from Southern Ontario and the United States. Large quantities of albertite (a variety of bitumen) have been raised from the Albert shales, in which it occurs as veins. The main vein of albertite was exhausted some time ago, but another has been found which may prove of considerable value.

The Albert shales have been extensively bored for petroleum supplies, with little or no success. Sometime in the future, however, when native oils become scarcer and distillation processes can be made to pay, these oil shales are likely to become important and valuable.

Quebec.—Coal is practically absent from the province. Thin seams occur in the Devonian shales on the south side of the Gaspé basin, and anthraxolite occurs here and there among the Cambrian rocks; but neither of these occurrences is of economic importance. Oil shales occur in the vicinity of Gaspé basin, and much expenditure has been incurred in oil-boring operations with practically no success.

In many parts of the province there are extensive peat-bogs, particularly in the area between St. John's and Farnham, where there appears to be a good prospect for the manufacture of compressed peat.

Ontario.—The northern portion of Ontario is occupied by ancient crystalline rocks, and contains no coal excepting occasional anthraxolite. There is an important deposit of lignite of post-Tertiary age in the area south of James Bay. This is not of such a good quality as the older lignites of the

west, but in the absence of better fuel it will probably become important for local uses.

Petroleum and natural gas are exploited in the south of the province, chiefly in the counties of Lambton, Haldimand, and Welland.

Western Canada.

East of the Rocky Mountains.—In this immense area, including Manitoba, Saskatchewan, and Alberta, and stretching through the Mackenzie territory to the Arctic Ocean, the rocks are to a large extent of Cretaceous age. In many places, and extending over large areas, these Cretaceous sediments include thick beds of lignite. When they approach the Rocky Mountains, the lignite is converted into bituminous coal, and in many places is even changed to anthracite, the change being more or less pronounced according to the degree in which the rocks have been affected by earth movement. These fuel deposits are in an undeveloped condition, and their exact extent has not yet been ascertained, but it is certain from what is already known that they contain a practically inexhaustible supply. In the area between Crowsnest and Banff, in the vicinity of the Rocky Mountains, the coal-bearing beds are several thousand feet thick and the coal seams exposed have a total thickness of 216 feet. It is estimated that in one portion alone of the Crowsnest basin, covering an area of 230 square miles, there is not less than 22,595,200,000 tons of bituminous coal of excellent quality.

Thick beds of lignite are exposed as far east as the Turtle Mountains in Manitoba, and they are seen along the courses of the North and South Saskatchewan rivers. They are also reported to occur in the vicinity of the Peace river, and they are known to occur along the lower part of the Mackenzie river and on several islands off the north coast.

West of the Rocky Mountains.—Coals, mostly bituminous, are found in many parts of British Columbia in various isolated basins and valleys. Good exposures occur in the vicinity of Nicola Lake, among the Tertiary sandstones and shales, in seams ranging from 2 to 18 feet in thickness. The coal is bituminous, of good quality, and yields excellent coke. Still further south, good coking coals occur on the Tulameen river,

while high-grade lignite coals occur on the Similkameen. The near proximity of these coal deposits to the mining districts of British Columbia, and the fact that the districts in which they occur are being opened up by the Canadian Pacific Railway, make them of great importance; and there can be little doubt that British Columbia will shortly be making extensive use of these immense fuel resources. Large quantities of high-grade Tertiary coal occur in the northern part of British Columbia, as at Bulkley Valley, south of the Skeena river, and also further north, at intervals, extending even into the Yukon territory.

High-grade bituminous coal occurs on the eastern edge of Vancouver Island, among the Cretaceous rocks, which stretch in a narrow band along the east coast. Mining centres occur at Comox, Nanaimo, and Ladysmith, where coal has been raised for half a century.

Graham Island, of the Queen Charlotte group, possesses large and important coalfields which are as yet undeveloped. Anthracite and bituminous coal of Cretaceous age occur in the south of the island, while in the north and east extensive areas are occupied by Tertiary beds, which carry good seams of lignite.

GENERAL NOTES.

Fibre from South Australia.—The attention of the Imperial Institute has on several occasions been directed to a fibrous substance which is found on the foreshore of Spencer's Gulf, South Australia, under a deposit of sand varying from 6 to 8 inches in depth.

This material consists of short, harsh fibre, somewhat resembling jute, and has a quantity of broken shells associated with it. The product is reddish-brown, of poor lustre and very uneven strength. Some of the long fibres are fairly strong, but the greater part are weak and brittle. The length of the fibrous strands varies from about 1 to 5 inches. The ultimate fibres are very short (about 0·03 to 0·05 inch) and from 0·0008 to 0·003 inch in diameter.

A specimen, which was submitted to chemical examination, furnished results which are compared below with those given by a sample of Indian jute. Before analysis the fibre was freed as far as possible from sand and fragments of shells.

	The South Australian fibre Per cent.	Indian jute extra fine quality. Per cent.
Moisture	11·8	9·6
Ash	6·1	0·7
α-Hydrolysis (loss)	0·4	9·1
β-Hydrolysis (loss)	1·9	13·1
Acid purification (loss)	7·8	2·0
Nitration (gain)	7·0	36·7
Cellulose	55·9	77·7

The behaviour of the fibre with reagents showed that it is highly lignified. The percentage of cellulose is lower than that of most fibres of terrestrial origin. The high percentage of ash is due to the particles of shells or sand which still adhere to the material, and the exceptionally small loss on hydrolysis is probably explained by the fact that the fibre has undergone prolonged exposure to the action of sea-water.

A series of experiments was made in order to determine the behaviour of the fibre when submitted to certain technical processes, such as carding, bleaching, and dyeing. When carded, the material furnished an excessive amount of short fibre, and on prolonged treatment the greater part became broken up. The fibre was found to be very difficult to bleach, but in the dyeing experiments it was found to behave very similarly to jute.

The fibre could be spun, either alone or mixed with jute, into a coarse yarn suitable for the manufacture of carpets and similar fabrics. There would, however, be excessive waste in the processes of manufacture and the finished products would be of inferior strength.

The fibre could be used as a paper-making material, although for this purpose the percentage of cellulose is low, and it would be necessary to remove the associated mineral matter. It is probable, however, that it would meet with a ready sale as a paper-making material if it could be placed on the market at a price, which would enable it to compete with other materials of this class.

The following interesting notes on this fibre are taken from the *Proceedings of the Linnean Society of New South Wales.*

"Mr. R. T. Baker exhibited a sample of vegetable fibre, which appeared like teased-out coconut fibre. This material is found at Tickera, fifteen miles north of Wallaroo, South Australia, and runs in a straight line from the beach inland in a generally easterly direction for some distance. At the beach it is fifteen feet wide, and at the eastern end it tapers out to a mere trace. The origin of this remarkable deposit is so far unknown, and a microscopical investigation determined it to be a vegetable, consisting of cellulose and lignin. Locally it is known as 'kelp,' but that is incorrect, as seaweeds do not contain vascular bundles" (*Proc. Linn. Soc. N. S. W.*, May 30, 1906).

"Mr. A. G. Hamilton exhibited a ball of vegetable fibre similar to that exhibited at the last meeting by Mr. R. T. Baker. It was picked up on a beach near Albany, Western Australia, where there was an area of three or four acres covered with balls and cylinders rolled by the action of the waves. The bay was shallow and the bottom covered with a thick growth of some grass-leaved plant like *Zostera*, and it was from the decayed leaves that the fibre was derived. As there were no flowers or fruit it was impossible to determine the plant" (*Proc. Linn. Soc. N. S. W.*, June 27, 1906).

"With reference to the fibre exhibited by Mr. R. T. Baker at the May meeting, and commented upon by Mr. A. G. Hamilton at the June meeting, Mr. Maiden expressed the opinion that it was probably the product of a marine plant, *Posidonia australis*, Hook. f. (*Naiadeæ*). 'The bases of the stems covered with the filamentous remains of old leaf-sheaths' is a character of the genus, those of *P. australis* being covered with longer and finer filaments than in *P. oceanica*, the European species. Mr. Maiden exhibited specimens of *P. australis* showing the fibre *in situ*, and he drew attention to the possible importance the finding of the *Posidonia* fibre may have from a geological point of view.

"*Posidonia* grows at the present day on the coasts of Tasmania and Southern Australia as far as New South Wales. The fibres are firmly attached to the plant, and it is, therefore, very unlikely that the fibres could have been washed on shore where they were found. The finding of the fibre appears to indicate not only that there has formerly been an ocean bed, but also that the depth of the water could not have exceeded the maximum depth in which *Posidonia* is found growing now" (*Proc. Linn. Soc. N. S. W.*, July 25, 1906).

Cultivation of Lemon Grass in Ceylon.—In a circular issued from the Royal Botanic Gardens, Ceylon (*Circulars and Agricultural Journal*, 1906, **3**. 19) Messrs. Wright and Bamber give an account of experiments on the cultivation of lemon grass conducted at the experimental stations in the island.

In the past the cultivation of lemon grass, *Andropogon citratus*, D.C., had been confined to the southern part of Ceylon, in districts about sea-level, having an annual rainfall of 100 inches or more, and an average temperature of about 80° Fah. Recently, however, it has been successfully cultivated at Peradeniya, at an elevation of 1,600 feet, in a district having an annual rainfall of about 82 inches. As regards climate there is a hot dry season for two months, then a hot moist season for a like length of time, followed by a cooler moist period for the rest of the year, the mean annual temperature being 75·5° Fah.

The soil is a sour, light-coloured, micaceous loam with little retentive power for moisture and poor in organic matter and nitrogen. Magnesia and potash are present in large quantities, but the soil is deficient in lime; the available potash is fairly good, whilst the phosphoric acid is poor.

The cultivation of lemon grass is very simple. Clumps of well-grown uncut grass are divided into "slips" or "shoots" and planted in holes about 2 to 3 feet apart. The planting is done in wet weather, and most of the slips throw out roots and set.

The grass grows rapidly, and forms "stools" 3 feet in height and 12 inches in diameter in from six to seven months. It can be cut from six to nine months after planting and three times in each succeeding year. The stools require replanting at intervals of about three years. Weeding is rarely necessary after the planting period. On some estates the ground is forked after the grass is cut and green manured. It is well to bear in mind that lemon grass is a very exhausting crop, 10,000 lb. of grass containing about 65 lb. potash, 12 lb. nitrogen, 12 lb. lime, and 9 lb. phosphoric acid. When the grass is used for fuel, after the extraction of the oil, the ashes are sometimes scattered over the ground for manure. Lemon grass may be cultivated as a single crop or as a catch crop, *e. g.* in rubber plantations.

The distillation of the oil from the grass is done in the same manner as for citronella. A drawing of the apparatus used is reproduced in the circular. It consists of a boiler, the steam from which passes into the steamer in which the grass is placed. This is a cylindrical vessel, 5 feet high and 4 feet in diameter, closed at the top with a flat lid fastened down with thumb screws. Near the top of the steamer is a pipe communicating with the condenser, which consists of a coil, 60 feet of 3 inch-bore piping, immersed in water. The lower extremity of the coil terminates above the receiver, which is fitted with a syphon arrangement by which the oil can be separated from the accompanying water. The grass is usually distilled in the fresh state; sometimes the larger bundles are cut into smaller pieces and slightly bruised before being steamed. It is then placed in the steamer, and steam is passed through until the oil is extracted, which usually takes from four to five hours. The crude oil is filtered through cloth and filter-paper, and when clear is sealed in tins, casks, or bottles. As a result of experiments it was found that 496 lb. of fresh grass yielded 1 lb. crude oil (0·2 per cent.), the estimated yield per acre, per year, being about 20 lb. of crude oil. The yield of refined oil is much less than this.

An examination of the lemon grass oil obtained at the experimental station was made by the Government chemist, who obtained the following results:—

	Per cent.
Aldehyde content	66·62
Phenol content (eugenol)	3·80
Optical rotation $[\alpha]_D$	0° 50′
Specific gravity at 30° C.	0·9106

"The sample of the oil was clear, but with a marked reddish colour. It gave a turbid solution, both with 70 per cent. and 80 per cent. alcohol."

He considered that the top of the still used for the experiments was not sufficiently high to prevent resinous matters and oxidised products being carried over mechanically with the steam, the value of the oil being thereby decreased. The use of steam at a high pressure was also deprecated on account of the liability to produce darkening and decomposition of the oil.

New Caoutchouc Plants of Madagascar.—In the *Comptes Rendus*, (1907, **144**. 1053), MM. Costantin and Poisson contribute a note, "On some Caoutchouc Plants from South Madagascar" discovered by M. Geay in 1906 whilst travelling in the Provinces of Tulear and Fort Dauphin. Two of these plants, of which the native names are "Kokomba" and "Kidroa," are exploited by the natives of the South-west Province of Tulear, who obtain caoutchouc from the roots.

The method employed is described as follows: The roots are pulled up and exposed to the sun to bring about the rapid coagulation of the acid latex; they are then tied together in faggots and conveyed to the village to be decorticated, which is done by beating them with a piece of hard wood. The separated bark is well beaten, again exposed to the sun, and then boiled with water to remove the broken bark from the rubber. This latter process of drying and boiling with water is repeated a second and third time, and the rubber thus obtained is fashioned into balls and enters the market in this form.

The "kokomba" plant is a new species of *Mascarenhasia* to which the name *Mascarenhasia Geayi* has been given by the authors. The "kidroa" is also a *Mascarenhasia*, for which the name *Mascarenhasia Kidroa* is proposed. It appears to be related to *Mascarenhasia pallida*, but has longer and narrower leaves than the latter. The distinctive characters of these species are described in the original paper.

In the region of Fort Dauphin two new *Landolphias* have been discovered, the fruits of which are quite distinct from those of *Landolphia sphærocarpa*, *Landolphia Perrieri*, and *Landolphia tenuis*, which occur in the west, and also from the species occurring in the east described by M. Prudhomme as *Landolphia madagascariensis.*

The knowledge of the caoutchouc-yielding plants of the east coast of Madagascar has been considerably modified recently by an important investigation conducted by M. Pierre, who has shown that the true rubber plants are the "Mandrianambo" (*Landolphia Mandrianambo*), the "Fingomainty" (*Landolphia hispidula*), the "Fingobary" (*Landolphia Dubardi*), and the "Talandoha" (*Landolphia Richardiana*), whereas *Landolphia madagascariensis*, according to the researches of M. Thirz, Inspector of Woods and Forests in Madagascar, contains only a difficultly coagulable latex, and gives a non-elastic product known as "Robanga." These various species have been observed only in the region of Maroansetra, *i. e.* towards the north, in the neighbourhood of the Bay of Antongil.

M. Geay also discovered in the neighbourhood of Fort Dauphin two

Landolphias, called by the natives "Mamolava" and "Mamavo," which appear to be new and are described by the authors of the paper as *Landolphia mamolava* and *Landolphia mamavo.*

"Malting" Coffee.—One of the difficulties with which the coffee planter has to contend is the prevalence of wet weather, constant or intermittent, at the period when he wishes to dry his produce for market. The coffee already pulped and fermented may get very wet, and if some days of sunshine then intervene it is liable to sprout and later to rot unless carefully handled.

Trouble of this nature having been experienced at Porto Rico, the idea occurred to Mr. J. W. Van Leenhoff to determine how long wet coffee could be kept without damaging its quality, and also whether the sprouting or malting had any influence on the flavour of the coffee (*Annual Report, Porto Rico Agricultural Experiment Station*, 1906).

Fermented and recently-washed coffee was placed on December 30, 1905, in a heap on a cement floor in a basement, and the heap was turned daily. Sprouting commenced towards the end of January, and the coffee was then spread out into a layer about one foot deep and turned daily. The upper layer as it became dry was sprayed with water.

By February 23 all the grains had germinated and the sprouts had attained a length about equal to that of the seeds. The coffee was now dried and hulled, and sent to various dealers, consumers, and roasters. Their reports were favourable, and Mr. Van Leenhoff states that to him personally "it seemed that the flavour of the coffee prepared thus was finer and that the bitter taste [of Porto Rico coffees] so much complained of had disappeared." More detailed experiments on the matter will no doubt be carried out, but these preliminary observations seem to point to the possibility of keeping coffee in the wet state for at any rate two months, not only without injuring it, but in the case of naturally bitter coffees actually improving its flavour.

The Jaipur and Nazira Coalfields, Upper Assam.—Mr. R. R. Simpson, B.Sc., late Mining Specialist to the Geological Survey of India, gives in a recently-published number of the *Records of the Geological Survey of India* (1906, Vol. xxxiv., **4.** 199) a detailed description of the Tertiary coalfields, which lie at the foot of Naga Hills, and which were first surveyed geologically by Mr. F. R. Mallet.

Chemical analysis shows the coal to be of excellent quality, though not quite so good as the Makum coal. It burns readily, with considerable flame and heat, but varies somewhat in character, some portions being hard and brittle, and others crumbling to pieces in the fingers; while many samples coke readily, others show little coking power.

Mr. Simpson accepts provisionally Mr. Mallet's estimate of fifty-five million tons for the two fields, but confines his own estimates to selected areas, which from their position and the quality, and the mode

of occurrence of the coal, seem to be of immediate practical importance; these include Borhat on the Disang river, Saffrai and its neighbourhood, and the region of the Dikhu river and its tributaries.

He recommends the last-mentioned as most suitable for the establishment of a colliery. It has an assured reserve of 2,210,000 tons of coal, with a promise of a still larger amount. The dip of the coal is only 20° to 35°, and it is less disturbed than in other areas examined. There would be no difficulties from underground water. On the other hand, it is from six to seven miles from the Assam-Bengal Railway at Santak, over difficult country, but the output could be cheaply dealt with by means of telpherage.

Recent Trials of New Zealand Shale.—Bituminous shale occurs in the upper portion of the coal formation of several localities in New Zealand. The total quantity raised in the Dominion up to 1905 amounted to over 14,000 tons, chiefly obtained from Orepuki, in Southland. Oil shales of good quality have also been obtained from the Chatham Islands, D'urville Island in Cook Strait, and Mangonui in Auckland.

Analysis of these made recently have given the following results:—

Locality.	Volatile matter.	Carbon.	Water.	Ash.	Sulphur.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
D'urville Island	81·79	7·98	0·69	9·54	traces.
Mangonui Island	75·20	9·30	1·80	13·70	,,
Chatham Islands	66·43	20·41	4·61	8·55	,,
,, ,, ...	64·67	19·87	7·13	8·33	,,

Oil shales also occur associated with brown coal and lignite at Ida Valley, Clyde, and Coal Creek Flat, Central Otago; Waiho river, Waimate, South Canterbury; and Waimea Creek, Orepuki, Southland. The latter deposit has received some attention, and an extensive plant was erected, but the works were closed in 1903 owing to the method of treatment proving too expensive and intricate to be financially successful.

In 1906 the New Zealand Government agreed to defray the cost of technical distillation trials on about 50 tons of the shale. These trials were carried out in Glasgow under the supervision of Sir Boverton Redwood, from whose recent report the following particulars are taken:—

The shale distilled was of uniform quality, but in somewhat small fragments, which probably caused a decrease in the yield of oil obtained. The distillation was carried out in an experimental retort, and occupied twenty days, during which time slightly over 50 tons of shale were distilled. The gas produced was more than necessary for the firing of the retorts, and if extracted with oil would yield at least 1½ gallons

of "petroleum spirit" per ton of shale. The average yield of ammonium sulphate obtained was 19·12 lb., and of crude oil 38·41 gallons (specific gravity 0·890) per ton.

A sample barrel of the oil, representing each day's yield, was examined by Mr. J. Wishart, who furnished a report on the refining of the oil. The yield of finished commercial products obtained was about the same as that obtained from crude Scottish shale oil and amounted to 70·7 per cent., of which 20·11 per cent. consisted of crude paraffin scale—an exceptionally high yield of this product. The oils obtained by fractionation were similar to the corresponding products obtained from Scottish shale, and were of marketable quality. It is pointed out that instead of fractionating the heavy oils they could be sold in bulk as liquid fuel.

The following is an estimate prepared by Mr. Wishart of the profits likely to be obtainable from working this New Zealand shale, and is based on the cost of mining and distilling Scottish shale and on the prices obtained for the refined products in Great Britain :—

		Per ton of shale. *Pence.*
Value of oils and scale paraffin		160·32
,, ,, ammonium sulphate, less cost of manufacture		19·12
		179·44
Cost of mining	51·0	
,, ,, distilling	12·0	
,, ,, refining products	30·72	
		93·72
Estimated gross profit per ton		85·72

NOTICES OF RECENT LITERATURE.

NEW BOOKS.

LE COCOTIER. By Paul Hubert. Pp. xiii. + 133, and numerous illustrations. (Paris: H. Dunod et E. Pinat, 1906.)

It is curious that in spite of the large amount of British capital invested in Colonial planting enterprises, and of the great number of British subjects engaged in such work, there should be such a singular dearth of manuals on tropical agriculture in the English language. In Germany, on the contrary, there are available such well-known treatises as those of Semmler and of Wiesner; and in French there are already obtainable one or more series of handbooks dealing with such matters,

in addition to the new "Bibliothèque pratique du Colon" which Messrs. Dunod and Pinat propose to publish, and in which the book now under notice forms the initial volume.

M. Hubert divides his book into three parts, the first dealing with the cultivation of the coco-nut palm, the second with its exploitation, and the third gives a list of addresses of institutions, journals, and firms likely to be of interest to those engaged in coco-nut planting.

A fairly full account is given of the best method of forming a plantation; the chief insect pests which affect the palms are enumerated, and methods for their destruction are discussed. A useful feature of this part of the work is the detailed estimate of expenses and receipts from the time of forming the plantation until it comes into full bearing.

In the second section the preparation of coir and coprah is discussed, and illustrations of some of the machinery used in preparing these products are given. The manufacture of coco-nut oil, both as practised by natives on a small scale and as carried on in some of the tropical factories equipped with modern presses, is described, and a short account is given of the preparation of "vegetable butters" from coco-nut oil, whilst the other common uses of the oil in soap and candle manufacture are briefly alluded to. Reference is also made to such products as palm wine, arrack, jaggery, and so on, obtained from the sap of the palm.

This book may be recommended to those concerned in coco-nut planting as giving a succinct and readable account of recent developments in the industries, using the coco-nut as a source of raw material; but regarded as an exhaustive manual on the subject it is rather disappointing, since the information given is often not sufficiently detailed. The volume is unfortunately also issued without an index.

LE BANANIER. By Paul Hubert. Pp. x. + 220. (Paris: H. Dunod et E. Pinat, 1907.)

This book is the second volume of the series of monographs dealing with French Colonial industries to be published under the general title of "Bibliothèque pratique du Colon." As the title of the series would indicate, the monographs are intended to be essentially practical in character; and in the volume under notice the information supplied should appeal to the man actually engaged in the planting of bananas and in the various industries connected with the products of the plant.

As is almost inevitable in a work of this kind, much of the information has been compiled from various sources, and a useful purpose is served in bringing together and summarising the experience gained by workers which would otherwise be inaccessible to many. The book is divided into four parts. In Part I. the botany of the economic species of *Musa* is dealt with, after a brief discussion as to the probable home of the genus. The question is somewhat summarily dealt with, and the concluding remarks, "Laissons les savants nous eclairer, en leurs discussions; quant à nous, plantons, exportons, mettons en valeur, produisons!"

would not appear to be in keeping with the subject-matter of some forty subsequent pages, which contain a not always illuminating list of native names of varieties grown in all parts of the tropics. The practical methods of cultivating the banana for both fruit and fibre are dealt with at considerable length, and the value of the information is much enhanced by quotations from the published work of Messrs. Cousins and Fawcett, of the Board of Agriculture of Jamaica, on questions of soil analysis and details of expenses and returns of established plantations. Similar information is supplied with regard to the fibre industry of the Philippines.

The various industries connected with banana products are dealt with in Part II. Comparatively little information is given with regard to the export of fruit, but a useful description of the methods employed in the preparation of dried bananas—exported at the present time, we are informed, almost exclusively to Denmark, Holland, and Scandinavia—and of banana flour is given, with illustrations of types of the necessary machinery. The information regarding the preparation of Manila hemp has been compiled from certain well-known sources.

Part III. is concerned with a general survey of the world's trade in banana products, due emphasis being laid on the overwhelming importance of the British and American fruit trades. The last part deals with a consideration of the possibilities of the banana industry in the French Colonies. In the opinion of the author the prospects for fruit growing are most promising in French Guiana and in the French West Indies, while Madagascar, the Comoro Islands, Nossi-Bé, and Indo-China offer the best opportunities for the establishment of a fibre industry.

THE BOOK OF ALFALFA: HISTORY, CULTIVATION AND MERITS. Its uses as a Forage and Fertiliser. By F. D. Coburn. Pp. xi. + 336. Numerous illustrations. (New York: Orange Judd Co., 1906.)

The author of this volume, who is the Secretary to the Kansas Department of Agriculture, has published already a small book on this subject, which appears to have been widely used by farmers in the United States. Mr. Coburn is a strong advocate of alfalfa (lucerne) cultivation and has collected assiduously the results of farmers' experience with it, in the widely different conditions of climate and soil obtaining in various parts of the United States.

There is reason to believe that the plant is a native of central Asia, and was taken by the Persians into Greece about 490 B.C., whence it was carried to Spain and other parts of Europe and Africa, and thence to Chile and Peru, from which sources it probably found its way into the United States, where its cultivation is now so extensive that, apart from the large quantities of seed produced internally, 2,865,324 lb. were imported in 1904–1905.

The author discusses in detail the value of alfalfa in comparison with other similar crops, its cultivation, the climate and soil conditions to which it is suited, and the precautions to be observed in growing it.

The value of the plant as a feeding-stuff for cattle, poultry and bees is considered in a series of nine chapters, and finally its place in the rotation of crops is discussed and attention is directed to its value as a soil renovator in virtue of the property it possesses, in common with other leguminous plants, of adding to the nitrogen content of soil in which it is grown.

Numerous well-printed illustrations add considerably to the value of the book, which should be found useful by farmers and planters interested in the cultivation of alfalfa either as a feeding-stuff or as a green manure.

THE JOURNAL OF THE SOUTH EASTERN AGRICULTURAL COLLEGE, WYE, KENT. No. 18. Pp. 430. (London and Ashford: Headley Bros., 1907.)

This bulky number of the journal contains general notes on the college by the principal, and separate reports on the farm and the departments of economic zoology, chemistry, botany, and the veterinary department by the various members of the staff. It is satisfactory to find that the number of students continues to increase, and that more use is being made of the college as an advisory centre for agricultural and horticultural matters.

Mr. F. V. Theobald embodies in his report on economic zoology full accounts of the life-histories of animals investigated during the year. There are many excellent illustrations showing the appearance of plants attacked by pests, and of the insects causing the damage. Notes are added as to methods of treatment.

On the chemical side activity appears mainly to have been devoted to the analysis of manures, feeding-stuffs, waters and soils. The botanical department records amongst other matters some preliminary observations on the conditions determining the damage done to fruit by frost. It is proposed to extend this inquiry next year.

Mr. E. S. Salmon's report on economic mycology naturally contains a full account of the American gooseberry mildew and the need for legislation to deal with such diseases, a question to which he has devoted much attention recently. Legislative powers have since been obtained by the passing of the "Destructive Insects and Pests Act, 1907." Numerous other fungoid diseases are also dealt with, and as in the case of the gooseberry mildew the reports are accompanied by excellent illustrations.

The botanical and chemical sections have co-operated in the production of a useful list of plants of the British Flora, and some foreign plants, poisonous to stock. In convenient tabular form is given the common and botanical name of each plant, its habitat, its poisonous properties (with references to published cases of poisoning), and finally the chemical substances present in the plant. Three groups are formed, containing (1) plants whose poisonous character is fairly well established such as yew, meadow saffron, dog's mercury, henbane, monkshood,

hemlock, to mention only a few examples; (2) those about which the evidence is less clear, *e.g.* potato, foxglove, box, darnel, wood anemone, field poppy and spindle tree; and (3) plants or seeds known to cause injury but which animals would not get in the ordinary way, *e.g.* corn-cockle (seeds), charlock, laburnum, Java beans, etc.

These brief references, although incomplete, will be sufficient to indicate some of the principal lines along which the work of the college is conducted, and for full information the volume itself should be consulted. It is foreshadowed that in future the reports on the different departments will be issued separately.

SEVENTH ANNUAL REPORT OF THE AGRICULTURAL CHEMIST FOR THE YEAR 1905–1906. DEPARTMENT OF AGRICULTURE, MYSORE STATE. (Bangalore: Government Press, 1907.)

The experimental farm of the Mysore Department of Agriculture is situated about five miles from Bangalore, and was taken possession of in January 1905. Before experimenting with various manures and methods of cultivation, it was decided to test carefully the uniformity of the land by giving as far as possible the same treatment to the crops on all the plots of a set. Paddy (rice) was grown on the plots of wet land, and the millet crop "ragi" (*Eleusine coracana*, Gaertn.) on the dry land. The results obtained are given in the report, and show the wisdom of this precaution; since the yields from some plots were more than double those from others. It is intended to grow further test crops, and then by a judicious disposition of duplicate plots based on the results it is hoped that the errors due to lack of uniformity in the land will be obviated.

The dry land was ploughed with a Canadian plough and cultivated with a horse-hoe before being sown with ragi, and it was observed that the yield was much superior to that obtained on adjoining land by the usual native methods of cultivation. This was attributed by the villagers to the difference in ploughing and led to a demand for similar ploughs, thus showing the interest that can be awakened by an experimental farm; in the report, however, the superiority of the plough is not yet regarded as established.

Experiments were continued on some small plots on the after effects of manures and some trials were made with sugar cane, caravonica cotton and ground nuts. The last were as badly diseased in 1905 as in the previous year, but treatment of the seed with a one per cent. solution of copper sulphate appeared to have a slight beneficial action. The factors which affect the availability of bone meal are being studied; it was remarked that on one of the Mysore coffee estates on which milled bone was applied in pits more than 28 years ago, it is still occasionally being dug up; on the other hand in an estate in Coorg, where bone meal is applied on the surface and is in the course of a short time covered by leaves, the bone disappears in a very short time and little of it can be found ten months after it has been applied.

Trials were made of threshing machinery for ragi and of various mills for crushing sugar cane, and the report concludes with an account of experiments on the penetration of water into the soil and the relative cost of manurial ingredients in various fertilisers offered for sale in Southern India. Attention is drawn to the possibility of using the ashes of Lantana as a potassic manure. This shrub has invaded the country and become a pest; however, its ash is found to contain 13·3 per cent. of potash soluble in water (the total potash soluble in acids being 15·7 per cent.); it is thus comparable with kainite as a manure, and in addition it contains 4·5 per cent. of phosphoric anhydride, and there is an inducement to burn it in districts where there is a demand for a potash fertiliser.

HANDBOOK OF AGRICULTURE, WITH ESPECIAL REFERENCE TO THE REQUIREMENTS OF SOUTH AFRICA. By the late Prof. F. Blersch, Principal of the Government School of Agriculture and Viticulture at Stellenbosch. Pp. x. + 437. (Cape Town, &c., J. C. Juta & Co., 1906.)

This book was prepared with the object of placing in the hands of South African farmers, agricultural teachers and students a reliable handbook of agricultural practice as suited to the special conditions prevailing in South Africa. Unfortunately before the work was completed Professor Blersch died, and the unfinished chapters on the dairying industry were concluded, upon lines which had been indicated by the author, by Mr. J. H. Overman, of the Government Agricultural School, Somerset East. It will be seen, therefore, that the book has been written by authorities who are fully acquainted with the local requirements and difficulties, and the character of the information supplied affords sufficient evidence of this fact.

The book is divided into three parts, dealing respectively with the Production of Plant Crops, the Breeding of Live-stock, and Dairying. The climate and soil of South Africa are dealt with in the early chapters of Part I., which are succeeded by a discussion of the meaning and aims of irrigation, questions of the highest importance to the countries concerned. While the enormous benefits of the practice are insisted upon, it is pointed out that careless and unscientific irrigation may tend to make the land brackish, a fact to be carefully borne in mind in dealing with many districts of South Africa, where the soils are exceptionally rich in mineral plant-food.

The information conveyed in the chapters dealing with the principal grain crops is of a very practical character, and should prove of considerable value to settlers taking up land not only in the countries especially dealt with, but in other Colonies where the conditions are not greatly dissimilar. The important question of forage, both natural and artificial, is discussed at some length, and an illustrated description of the more important poisonous plants occurring on the veldt is given. The author emphasises the importance of lucerne (alfalfa) to South

African farmers, but comparatively little mention is made of the valuable experiments with both indigenous and foreign grasses, which have been made recently in various parts of the country, notably in the Transvaal by the Government Agrostologist and Botanist.

Parts II. and III., dealing with Live-stock and Dairying, occupy nearly one-half of the work, and contain much information of a practical nature. The volume is well illustrated throughout.

INDUSTRIES OF THE CAPE COLONY. Compiled by the Department of Agriculture, Cape Town. Pp. 172. (Cape Town: The Department of Agriculture, 1906.)

This book was prepared as a guide to the Cape Colony for the purposes of the South African Products Exhibition, 1907, held in London. The chief object of its compilation was to draw the attention of the public more especially to those industries in which there is a distinct possibility of development, with promise of profitable investment. Many of the articles have been contributed by gentlemen practically interested in the industry dealt with, and the remainder have been written by officers of the Department of Agriculture. The most important articles are those on "The Angora Goat and the Mohair Industry," "Ostrich Farming," "Viticulture," "Tobacco," "Cereals," "Sheep Farming" and "Fruit Culture."

THE ORANGE RIVER COLONY: ITS RESOURCES AND DEVELOPMENT. Pp. 78. (Bloemfontein: Government Printers, 1906.)

This handbook was compiled, chiefly by the heads of the Government Departments, for use as a guide to the Orange River Colony Section of the South African Products Exhibition, 1907, held in London.

The opening chapter serves as an historical introduction. It is followed by an account of the Colony as it is to-day in respect of population, government, administration of justice, and education; the important native labour question is also dealt with, and an account is given of the railway system of the Colony.

The greater part of the book is concerned with Land Settlement and Agriculture. As regards the latter, experience would tend to show that purely agricultural farming in the Colony cannot be regarded as a safe investment, on account of the precarious rainfall, and the presence of pests, prominent among which are locusts. The Colony is essentially a stock-raising country, sheep-farming being by far the most important industry. It is not improbable that in the future the mixed farming carried out at the present time will, with the exception of the cultivation of maize, entirely give place to the raising of stock.

The book concludes with an account of the important diamond-mining industry, and expresses the opinion that the prospects of the Colony from the mining point of view are extremely hopeful.

MY EXPERIENCES OF THE ISLAND OF CYPRUS. By B. Stewart. Pp. 260. (London: Skeffington & Son, 1906.)

The author, who has been engaged in railway work in Cyprus in recent years, gives an account of its chief places of interest, with notes as to their past history; he describes its present condition and relates his experiences when travelling in the Island. He calls attention to the advantages that would arise by improving agriculture and by giving a direct and regular mail service with Egypt, which affords a market for the live-stock and agricultural produce of the Island. His views in many respects support the recommendations embodied in the "Report on the Agricultural Resources of Cyprus, with special reference to Cotton Cultivation," made by Professor Wyndham Dunstan to the Colonial Secretary [Cd. 2717 of 1905], a brief account of which is given in this *Bulletin* (1906, **3**. 327).

THE HANDBOOK OF JAMAICA FOR 1907. By J. C. Ford and Frank Cundall. Pp. 575, with two maps. (Kingston, Jamaica: Government Printing Office, 1907.)

This well-known and most useful handbook brings with it this year a reminder of the great disaster which overwhelmed Kingston early in the year. The book was nearly completed when on January 14th the earthquake occurred, and a large amount of the type set up was rendered useless. A brief account is given of the earthquake and of the subsequent events up to the end of April, together with notes on the alteration of sites of government and other offices necessitated by the destruction of their former buildings. The new features in this edition include a classified bibliography of the Colony, and short obituary notices of prominent men connected with the Island who have died during the year.

The standing of the book is recognisable from the fact that this is the twenty-seventh year of issue, and like its predecessors this volume contains a mass of useful and reliable data concerning the Colony.

CANADA'S CENTURY. By R. J. Barrett. Pp. xiv. + 538. (London: The Financier and Bullionist Ltd., 1907.)

In the autumn of 1906 Mr. Barrett made an extensive tour of the Dominion, and his observations, together with statistical and other information, supplied the material for a series of articles in the *Financier and Bullionist*. These articles are embodied in the present volume, to which Lord Strathcona, the High Commissioner for Canada, contributes an appreciative introduction. The work is divided into sections, each dealing with a single topic, such as agriculture, minerals and mining, forestry, land enterprise, banks, railways, &c. The immense natural resources of the Dominion are well set forth, and especially helpful to those wishing to make a rapid survey of the potentialities of the country are the summarised conclusions printed in bold type at the end of each chapter.

Canada has made great strides in the past, but her natural assets are enormous, and the object of the author has been to endeavour to make

these more fully understood by the British public and by British capitalists and investors in particular.

HISTORICAL GEOGRAPHY OF THE BRITISH COLONIES. Vol. VI. AUSTRALASIA. By J. D. Rogers. Part I. Historical, Pp. vii. + 308. Part II. Geographical, Pp. 132. (Oxford: At the Clarendon Press, 1907.)

This volume is one in Mr. C. P. Lucas's well-known series of handbooks on the historical geography of the British Colonies; the revised editions of some of the other volumes have been noticed recently in this *Bulletin*. In Part I. the events which have resulted in the development of the Commonwealth of Australia and the Dominion of New Zealand are traced from the early days when men discussed whether there was a great Southland, and thought, as the Aristotelian did, that there was, if for no more logical reason than that the southern must be like the northern hemisphere.

The second portion deals in successive chapters with the geography of the Pacific Islands, New Guinea, New Zealand and Australia. The controlling influence of the physical features is well brought out. Thus in Middle Island of New Zealand "Geography has decided that the east shall be richest in corn and the north-west in minerals; that the south shall be richest and the north poorest in both combined; and the structure, shape and direction of the great range contain the key which unlocks every geographical secret."

The book contains numerous maps, and the two parts are separately indexed. Like each of its predecessors, it should prove of great service in affording a concise and self-contained account of one of the component parts of the British Empire.

MODERN ARGENTINA, THE EL DORADO OF TO-DAY; WITH NOTES ON URUGUAY AND CHILE. By W. H. Koebel. Pp. xv. + 380, with 123 illustrations. (London: Francis Griffiths, 1907.)

This book gives a very readable account of the present condition of Argentina. Six out of the thirty-three chapters are devoted to the description of Buenos Aires, which in transport and other facilities seems to be in no way behind any of the European capitals.

The remainder of the book is for the most part concerned with life in "the camp," and the agricultural industries with which the present and future prosperity of the country is so largely bound up. The principal crops are wheat, maize and flax, and the production of the first two is rising rapidly. Great progress has also been made in cattle-breeding, and interesting descriptions of some of the largest and best-managed estancias are given. Like other tropical and sub-tropical countries, Argentina suffers from occasional visitations of locusts; hares and rabbits, which have been introduced for sporting purposes, may prove troublesome in the future to agriculturists, but otherwise the country is fairly free from pests.

Though the Argentina railways are still mainly in the hands of British capitalists, the author appears to be of opinion that in other branches of industry other nations are securing relatively larger proportions of trade. Mr. Koebel's book will no doubt be the means of stimulating interest in Argentina industries.

MATERIALS FOR A FLORA OF THE MALAYAN PENINSULA. Part I. H. N. Ridley, F.R.S. Pp. 233. (Singapore: Printed at the Methodist Publishing House, 1907.)

A general flora of the Malayan Peninsula has long been a desideratum, and it is with great pleasure that all interested will welcome this first instalment of the work, which promises to bring together in readily accessible form the results of the many years of collecting and research devoted by Mr. Ridley, Director of the Botanic Gardens, Singapore, to the plants of this extraordinarily rich botanical region of the world.

The volume under notice is devoted to three natural orders only, and their relative importance in the region can be estimated readily from the space devoted to each. The account of *Hydrocharideæ* occupies four pages, the *Apostasiaceæ* two pages, whilst that of the *Orchidaceæ* fills some 224 pages.

A full description is given of each plant, together with its general geographical distribution, and the list of localities where it has been found in the Malayan Peninsula. The plants of the orders included in the volume are not as a rule of economic importance, nor are they plants likely to have definite native names. In one or two instances, *e.g. Enhalus Kœnigii*, the native name is recorded, together with the note that the fruit is eaten by children. It is to be hoped that these may be taken as an indication that such facts will be regularly given when the author deals with groups containing plants of economic interest.

Although no statement is made on the subject, it is also to be hoped that Part I. will be speedily succeeded by further parts, so that within a reasonably short period there may be available, in published form, as complete an account as possible of present knowledge regarding the "Materials composing the Flora of the Malay Peninsula."

THE TASMANIAN FLORA. By Leonard Rodway. Pp. xix. + 320. (Tasmania: Govt. Printer, 1903.)

The author, who is the Government Botanist of Tasmania, describes his work as mainly designed to encourage junior students to take a general interest in the vegetable beings living in the State. The volume appears well designed to serve this purpose, keys being given to facilitate the "running down" of a plant, first to its natural order, then to the genus, and finally to the species. The description of the plants are short and have been kept as free as possible from technicalities. Notes on the general geographical distribution and habitats in Tasmania,

and flowering periods, are appended. There are also a number of illustrations by the author of more interesting species.

In addition to the special value of the volume in Tasmania, botanists in many other parts of the world are glad to have in this compact form an account of the plants of the Island, including as it does not only the native, but also introduced species. Many genera of the British flora are represented in Tasmania, although often by different species, *e. g.* of *Ranunculaceæ*—the four Tasmanian genera are Clematis, Anemone, Caltha and Ranunculus—but except for representatives of the ubiquitous water crowfoot (*Ranunculus aquatilis*) no species is common to Great Britain and Tasmania, although of course all these genera are represented here also. Four European "buttercups" are, however, treated as introduced plants. The warmer climate is well indicated by the presence of eighteen species of Eucalyptus, to mention only one characteristic example.

PEAT: ITS USE AND MANUFACTURE. By P. R. Björling and F. T. Gissing. Pp. vii. + 173, with 60 illustrations. (London: C. Griffin & Co., Ltd., 1907.)

This is a comprehensive work on peat and the manufacture of peat fuel.

Chapter I. deals with the formation, growth and distribution of peat, and in Chapter II. a useful series of analyses is quoted. Methods of extracting peat are discussed in the next two chapters, and the remainder of the book is mainly devoted to the consideration of the manufacture of fuel, and a useful account is given of the various processes which have been used or are proposed for this purpose. A clear and succinct description is given of the electric process of producing "peat-coal," which is of special interest on account of its novelty. The process was invented by Mr. J. B. Bessey, and a complete plant for the manufacture of electro-peat-coal has been erected at Kilberry, near Athy, Co. Kildare, Ireland, on the estate of the Duke of Leinster, and a similar trial plant is at present in course of erection at the Rattlebrook peat works, Dartmoor, Devon. The plant at Kilberry is capable of dealing with 300 tons of raw peat per day. In this process the peat is taken from the bog by means of a "grab scoop," which delivers it into small tip-wagons running over a light railway by wire-rope haulage between the bog and the factory. The peat is fed into a rotary hydro-eliminator, in which it is subjected to a gradually increasing pressure, which eliminates the "free" water. The action is continuous, the wet peat passing in at the top and leaving partially dried at the bottom. The peat then passes into the trough of the electrifying machine, which is moved forward and backward by a reciprocating plunger, each stroke causing a discharge of peat. While this is going on, an alternating electro-current is passed through the peat, the effect of which is to liberate the "latent" water in the cells of the peat fibre so that it is easily extracted by a second hydro-eliminator, from which it is passed to the kneading and briquetting

machines. The whole of the machinery is operated by electricity, and the steam for driving the engines for the dynamos is generated by combustion of the surface turf. The fuel produced is hard, dense and comparatively smokeless. The cost of production is said to be low.

Information is also given on the utilisation of peat for other purposes than fuel, such as manure, cloth, paper and paving-bricks. The book is copiously illustrated, and contains a good bibliography and list of patents relating to peat.

PRACTICAL COAL-MINING. Divisional—Volume II. Pp. vi. + 161–348, together with five plates and numerous diagrams. (The Gresham Publishing Company, London, 1907.)

This is a continuation of the conjoint treatise on coal-mining edited by Professor W. S. Boulton. In the present volume Professor Henry Louis continues his dissertation on shaft-sinking, which he treats in an exhaustive manner. Mr. H. R. Bulman contributes an article on breaking ground, which deals with explosives, drilling, driving stone drifts, and coal-cutting machinery, while Professor Roberton of Calcutta describes methods of working coal-seams and timbering.

The high standard of excellence set in the first volume is well maintained in this issue.

SAND AND CLAY: THEIR ANALYSIS AND PHYSICAL PROPERTIES. By A. C. Passmore. Pp. i. + 48. (Manchester: The Technical Publishing Co., Ltd., 1907.)

This little volume gives much information of a practical nature regarding the industrial uses of sand and clay. The title of the book is rather misleading, as nothing is said regarding the analysis of sand or clay. The formula for silica is wrongly given as SiO (p. 5) instead of SiO_2. Many technical words are misspelt, *e.g.* diliquiscent (p. 11), pilocene, lacustorine (p. 25), and arquillaceous (p. 26). Further, statements such as "sand employed in actual work frequently has five per cent. to eight per cent. of suspended matter" are lacking in clearness. The assertion that "plasticity is essentially a hydrated silicate of alumina" is curious.

In preparing a new edition it would be well for the author to obtain the assistance of a scientific man to read the proofs with a view to avoiding weaknesses of the kind referred to.

MALAY TIN-FIELDS. (Printed by the Straits Times Press, Ltd., Singapore, 1906.)

This is a reprint of articles by Mr. Stokes, which originally appeared in the *Straits Times*. A useful and interesting account of the present condition of the Malay tin-mining industry is given.

The author deals rather briefly with the operations of the Chinese miners, although these are responsible for the greater part of the Malay tin output. The work carried on by the more modern methods of

companies operating under European influence is dealt with at greater length, probably because it is of greater significance in connection with future developments. The pamphlet concludes with a summary of the various opinions held by different mining authorities with regard to the present outlook of tin mining in the Malay.

HOW TO USE WATER-POWER. By Herbert Chatley. Pp. xii. + 92. (Manchester: The Technical Publishing Co., Ltd., 1907.)

The object of the author has been to give in small compass an account of the various ways in which water may be utilised for the production of power and its application to the running of machinery.

The first two chapters deal with the sources and transmission of water-power, and are followed by an account of the hydraulic press and its application to modern machinery for forging, plate-bending, riveting, and lifting. Illustrations of various forms of these machines are given. The use of water-wheels and turbines, and the working of pumps and hydraulic engines are briefly dealt with.

There are also special chapters on tidal power, water-supply, and sewage disposal.

ANALYSE DES METAUX PAR ELECTROLYSE. By A. Hollard and L. Bertiaux. Pp. iv. + 180. (Paris: H. Dunod et E. Pinat, 1906.)

Electrolytic methods of separating and estimating the constituents of commercial metals and metalliferous minerals have been extensively employed in recent years, and M. Hollard in particular has done much towards the investigation of the conditions under which such processes may be successfully applied. The present volume deals systematically with this subject.

Part I. is devoted to the description of apparatus, and the laws regulating electro-deposition are briefly considered. Part II. deals with the application of these rules to the separation of the principal metals, and Part III. gives special methods for the analysis of metals, alloys, and minerals used industrially. Part IV. contains tables showing the experimental errors and the degree of accuracy which can be obtained in each process. These tables are drawn up largely from the authors' own results.

The work will be found useful to those who are interested in the analysis of metals, alloys, and metalliferous minerals.

THE INTERACTION BETWEEN MINERALS AND WATER SOLUTIONS. By Eugene C. Sullivan. Bulletin No. 312 of the United States Geological Survey. Pp. 69. (Washington: Govt. Printing Office, 1907.)

This bulletin deals with experimental work carried out by the author to determine the action of certain crushed minerals (chiefly rock-forming silicates) on solutions of various metallic salts. The first part is occupied by an account of the views and experimental results of earlier workers. The second half is devoted to Mr. Sullivan's own results, which are of

considerable interest, especially on account of their bearing on certain phases of ore deposition.

Experiments at ordinary temperatures, with finely-divided kaolin in contact with cupric sulphate solution, show that an exchange of bases takes place in equivalent quantities between the kaolin and the solution. Hence the extraction of copper from its solutions by kaolin appears to be due not to mechanical surface attraction (adsorption), but to chemical interaction; and according to Mr. Sullivan "if adsorption is lacking in the case of kaolin, it seems reasonable to assume that it is lacking in the cases of other silicates." This conclusion is confirmed by the results of many experiments on various solutions in contact with mineral silicates, such as felspar, pyroxene, amphiboles, olivine, etc.

From these results it is inferred that "the natural silicates precipitate the metals from solutions of salts, while at the same time the bases of the silicates are dissolved in quantities nearly equivalent to the precipitated metals. The bases most commonly replacing the metals in these processes are potassium, sodium, magnesium, and calcium. Where exact equivalence is wanting, it is attributable either to solubility of the mineral in pure water or to the precipitation of basic salts. In these cases metals are precipitated as hydroxides or basic salts (in the case of cupric sulphate for instance, as a basic cupric sulphate similar to brochantite or langite) with more or less metallic silicate."

The results thus obtained are chiefly interesting as experimental illustrations of a phenomenon which is known to have taken place on large scale in nature, in connection with the secondary deposition of metallic ores. The phenomenon referred to is the process of metasomatism, whereby large rock masses which were originally non-metallic have become converted into rich metallic ores, through the agency of percolating solutions of metallic salts.

COLONIAL PUBLICATIONS.

Copies of the following publications descriptive of the resources of British Colonies and Dependencies have been received recently. They are available for distribution at the Central Stand in the Exhibition Galleries, free of charge so long as numbers permit, excepting any to which a price is affixed.

Canada.

Report on Acreage and Condition of Growing Crops. July 1906. Bulletin No. 3, Statistical Branch, Department of Agriculture, Government of Saskatchewan. Pp. 1–24. A detailed report is given of the weather and agricultural conditions for each district. The

areas, in acres, under the chief crops were: Wheat, 1,336,869; Oats, 545,243; Barley, 41,473; Flax, 30,582; Spelt, 1,566. All show a marked increase on preceding years.

CONDITION OF THE CROPS AT HARVEST TIME. September 20, 1906. Saskatchewan. Bulletin No. 4, Statistical Branch, Department of Agriculture. Government Printer. Pp. 1–24. This bulletin is in continuation of the one noted above, and contains reports on the crops in the various districts at a later date, with any necessary revision of acreage.

HANDBOOK OF BRITISH COLUMBIA. Bulletin No. 23, Bureau of Provincial Information, 1906. Pp. 1–67. A general account of the position, advantages, resources, and climate of the Province, with practical information on mining, lumbering, farming, ranching, fruit-growing, fishing, &c. Land regulations, prices of land, advice to immigrants, and allied topics are also discussed.

WAGE-EARNERS BY OCCUPATION. Bulletin No. 1, Census and Statistical Office, Canada, 1907. Pp. xxviii., 105, and xl. The bulletin has been compiled from data collected in the census of 1901. The number of wage-earners in each class (agricultural, manufacturing, professional, &c.) is given for the Dominion and for each of the Provinces. More detailed information on the sub-divisions of each of these primary groups is then given for Canada as a whole, the extent to which the analysis is carried being indicated by the fact that under "Cotton factory operatives" no less than some eighty separate occupations are recognised. The bulletin is printed in both English and French.

CANADA IN THE TWENTIETH CENTURY. Issued by direction of the Minister of Agriculture. Pp. 40. A general account of the Dominion, accompanied by a map and many illustrations. To all interested in Canada the pamphlet should prove of great service, giving as it does a good idea of the modern development of the country. Special information is included for the benefit of would-be settlers.

BRIDGING THE RIVERS. Issued by the Canadian Northern Railway. A book of views illustrating the building of the Canadian Northern Railway, with especial reference to bridging the Saskatchewan River. There are also scenes portraying agricultural life in the region.

CANADIAN NORTHERN RAILWAY. POCKET MAP. A map of the Dominion of Canada, showing the Canadian Northern Railway and other systems in operation.

SASKATCHEWAN VALLEY ROUTE. Issued by the Canadian Northern Railway. A map with general information and time tables.

WESTERN CANADA'S AMAZING WHEAT CROPS. Issued by the Canadian Northern Railway, Winnipeg, Manitoba. A popular illustrated account of cereal culture in Manitoba entitled "Excerpts from a story of a grain of wheat," statistical information, useful matter for intending settlers, and a map of the Canadian Northern Railway and its connections.

COBALT. THE ELDORADO OF NEW ONTARIO. 7th Ed. Pp. 16. Issued by the General Passenger Department of the Grand Trunk Railway System. The discovery of the rich cobalt and silver deposits in this region of Ontario is briefly recorded, and an account given, illustrated with a sketch map and pictures of mines and veins, of the chief mineralogical features. The difficulties which the prospector has to encounter are also indicated.

MONTREAL AND QUEBEC. Pp. 40. Issued by the General Passenger Department of the Grand Trunk Railway System. This very well illustrated little handbook affords a large amount of information about Montreal and Quebec, which are described as the two most interesting cities in Canada. Attention is chiefly directed to their history and points of interest to visitors.

South Africa.

SOUTH AFRICAN PRODUCTS EXHIBITION, 1907. Pp. 64. In addition to the catalogue of exhibits the pamphlet contains information regarding the natural resources of the Cape Colony and Natal, Orange River Colony and Rhodesia, and the mining industry of the Transvaal. There are also some illustrations.

LAND SETTLEMENT ORDINANCE, 1902. Orange River Colony. The text of the ordinance providing for the lease or sale of Government lands to approved settlers.

THIRD ANNUAL REPORT OF THE MINES DEPARTMENT, Orange River Colony, for the statistical year ending June 30, 1906. Bloemfontein. Pp. 49. A general summary is given of the year's work, and detailed information under the following heads:—Producing mines, diamonds, coal and salt, prospecting diamonds, petroleum, gold, coal, gypsum, lime, clay, etc.; the possibilities of cement manufacture in the Colony; the flow of water in the Vaal River; the mining revenue showing progress since 1898.

ILLUSTRATED HANDBOOK OF NORTH-EASTERN RHODESIA. Pp. 8. Issued by the British South Africa Company. It is worthy of note that the book is issued by the *Administrative Press* of North-Eastern Rhodesia, the staff of which is composed of natives under the control of a European printer. The book, which is accompanied with a map, gives an account of the physical features, the inhabitants, the mode

of administration, and much other interesting matter regarding this territory.

RHODESIA. Issued by the British South Africa Company. Pp. 32. Brief notes, with illustrations and a map, to draw the attention of tourists, sportsmen and others to some of the chief points of interest in the country.

RHODESIA. GUIDE TO THE VICTORIA FALLS. Issued by the British South Africa Company. A description of the falls, accompanied by illustrations and a coloured plan.

AGRICULTURAL AND PASTORAL RHODESIA. By G. M. Odlum. Issued by the British South Africa Company. Pp. 10. The author describes South Africa (except the Karroo) from the agriculturist's standpoint as consisting of "vast areas of grazing land: limited pockets of fertile soil: widely scattered farms: here and there an irrigation colony." He points out the great resources of Rhodesia, also the difficulties to be surmounted. Cattle, maize and tobacco, and in a minor degree sheep, swine and small grain, he regards as the chief profitable industries; in addition there are fruit, vegetables, butter, eggs and fowls. The pamphlet should be of great interest to intending settlers in Rhodesia.

REPORTS ON LAND SETTLEMENT IN SOUTHERN RHODESIA. 1906–7. By C. D. Wise. Issued by the British South Africa Company. Pp. 29. The reports contain Mr. Wise's scheme for land settlement in Rhodesia. The general principles which will be pursued in allotting farms in the settlement areas are:—

(1) Temporary accommodation and opportunities for practical experience to be provided, and a portion of the land to be cultivated before arrival of settler.
(2) Occupation of land to be enforced.
(3) Payment for land, house and improvements to be spread over a number of years, with interest on unpaid balance.
(4) Assistance in providing live-stock.
(5) Co-operation in marketing produce.
(6) Reservation of alternate blocks by the Company.

The reports contain much interesting matter regarding the products and resources of Rhodesia.

LAND FOR SETTLERS IN SOUTHERN RHODESIA. Pp. 5. Issued by the British South Africa Company. The pamphlet summarises the conditions on which land can be obtained on agreement from the Company, and also gives general information as to the price of land, the Central farms, facilities for reaching Rhodesia and for transport

when in South Africa. A form is attached to be filled up by candidates for admission to one of the Company's Central farms.

THE WINTERTON SETTLEMENT, NATAL. Pp. 13. Published by authority of the Land Board, 1905. Irrigation allotments are available for settlers at the Winterton Settlement, lying between Springfield and Colenso on the southern bank of the Little Tugela River. The minimum amount of capital required is estimated at £250. The locality is suitable for raising maize (mealies), oat hay, potatoes, onions, Kaffir corn, wheat, tobacco, vegetables, and fruits such as peaches, apricots, apples, pears, oranges, lemons and grapes. Dairying, bee-keeping and pig-raising are also recommended. The pamphlet contains notes as to outfit and much other information valuable to intending settlers.

Australia.

YEAR-BOOK OF NEW SOUTH WALES, 1907. Circulated by the Agent-General for New South Wales. Pp. 176. These year-books are well known, and the present one affords the usual comprehensive information regarding the State. It contains a map. Amongst subjects of economic importance, forestry and mineral resources are fully treated.

NEW SOUTH WALES. PLEASANT PLACES CONVENIENT TO RAILWAYS. Issued by the authority of the New South Wales Railway Commissioner. Pp. 78. The object of this publication, which contains numerous illustrations and a map, is to afford information concerning interesting places within easy reach of the railways of the State. Although primarily intended for local use, it would interest many desirous of learning something of the physical features of New South Wales.

VICTORIA: THE GARDEN STATE OF AUSTRALIA. Pp. 24. A *résumé* of information relating to the trade and commerce, financial position, products and resources, and prospects for settlers in the State.

THE FIRST FIFTY YEARS OF RESPONSIBLE GOVERNMENT IN VICTORIA. Pp. lxvii. + 19. Printed by order of the Legislative Assembly, Nov. 20, 1906. A brief retrospect of the history of Victoria since the grant of responsible government in 1856, including a complete list of the occupants of the principal offices during the period and statistics illustrating the progress achieved in the domain of natural products, manufactures and commerce.

VICTORIA. A REVIEW OF THE BENT ADMINISTRATION, 1903–4 TO FEB. 1907. Pp. 133. By Authority, Government Printer, Melbourne. The first 56 pages contain the substance of a speech delivered by Mr. Bent, the Premier, at Brighton, Victoria, in Feb. 1907. The remainder

of the publication affords summarised and statistical information of work done in the various departments of the Government.

VICTORIA. A SHORT GUIDE FOR INTENDING EMIGRANTS. Pp. 16. Issued by direction of the Minister of Lands, January 1907. The pamphlet contains information of the character indicated by its title. It is illustrated, and has a map showing location of free State schools, towns with public waterworks, reservoirs and weirs, districts with public irrigation supplies, and those with public domestic and stock supplies, and the distribution of the rainfall.

OFFICIAL ILLUSTRATED GUIDE TO ADELAIDE AND ENVIRONS. Issued by the Corporation of the City of Adelaide. Pp. 216. The book contains information of the character usually found in guide-books, a plan of the city, numerous illustrations, and an index.

REPORT ON COTTON GROWING. NORTHERN TERRITORY OF SOUTH AUSTRALIA. By the Hon. J. G. Jenkins. Government Printer, Adelaide, 1906. Pp. 3. The report discusses briefly the causes which brought about the shortage of cotton in 1903, and the question of the suitability of the soil and climate of the Northern Territory of South Australia for the cultivation and production of cotton.

REPORTS, GEOLOGICAL AND GENERAL, RESULTING FROM THE EXPLORATIONS MADE BY THE GOVERNMENT GEOLOGIST AND STAFF DURING 1905. Northern Territory of South Australia, North-Western District. Government Printer, Adelaide, 1906. The contents include reports on the general geology of the district; the Melville and Bathurst Islands; mines and minerals; soil analyses; contributions to the palæontology of South Australia. Appended is the itinerary and miscellaneous papers, with journal and detailed description of the country traversed, an account of the primitive methods of Chinese mining, and historical notes on the early days of mining in the Northern territory. The reports are illustrated, and there are in addition a geological map and section, a map showing distribution of economic minerals, plans and sections of Iron Blow and Mount Elliston Mines, and a panoramic view of the coast line from Providence Hill to Macadam Range.

GOVERNMENT RESIDENT'S REPORT ON THE NORTHERN TERRITORY, 1905. Pp. 51. A general report on the territory, with discussions of important economic topics such as labour supply, closer settlement, horse-breeding, mining, &c., thus affording altogether a comprehensive summary of the present conditions and future prospects of the territory. Reports on the various Government departments are appended. The Curator of the Botanic Gardens notes the successful experimental cultivation of cotton, sisal hemp, rice and rubber plants.

HANDBOOK OF SOUTH AUSTRALIA. Pp. 23. Issued at the office of the Agent-General for South Australia. General information on the

Commonwealth is followed by an account of South Australia, written particularly with regard to helping the would-be settler to gain an idea of the natural resources, general condition and cost of living in the State. South Australia, including the Northern territory, is approximately four times the size of France. The Northern territory alone comprises 335,116,800 acres, and exclusive of aboriginals has only 3,700 inhabitants.

New Zealand.

NEW ZEALAND: THE IMMIGRANTS' GUIDE AND SETTLERS' HANDBOOK. Compiled by direction of the Hon. the Minister of Lands. Wellington. Pp. 416. This is a new issue of the "Settlers' Handbook," but covers a wider field as indicated in the title. The information afforded "has been compiled as much for the immigrant who may reach these shores from the Mother country of Great Britain, as the settler who is manfully facing the difficulties and enduring the privations at first attending the making of a home in the far back forest or fern country in this not inaptly termed 'Britain of the South'." The result is a handbook of general information, and a store of practical information which should prove of the greatest interest and value not only to those for whom it is primarily intended, but also to all interested in New Zealand.

SOUVENIR OF NEW ZEALAND. The contents comprise good reproductions of 40 photographs issued by the New Zealand Tourist Department, with brief descriptive notes.

THE MINERAL WATERS AND HEALTH RESORTS OF NEW ZEALAND. Part I. Rotorua. By A. S. Wohlmann, M.D., B.S. Issued by the New Zealand Government Department of Tourist and Health Resorts. Pp. 48. The author is the Balneologist to the New Zealand Government, and this description of the health resorts of the Dominion has been prepared chiefly for the guidance of invalids recommended change, travel, or mineral water treatment. General information on health resorts is followed by a full description of Rotorua and its mineral waters, of which analyses are given. Numerous illustrations and diagrams add to the interest of the work.

NEW ZEALAND IN A NUTSHELL. Published by Authority, Government Printer, Wellington, 1907. Pp. 21. The pamphlet contains a large amount of statistical information arranged, under convenient heads. The numerous illustrations include typical scenery, Maoris, shipping New Zealand hemp, butter factories, and agricultural and pastoral scenes.

FACTS ABOUT NEW ZEALAND. Issued by the New Zealand Government Department of Tourists and Health Resorts. The letterpress is the same as in the preceding pamphlet, and there is a map of New Zealand, but no illustrations.

CROWN LANDS GUIDE FOR THE LAND DISTRICTS OF NELSON, MARLBOROUGH, WESTLAND, CANTERBURY, OTAGO AND SOUTHLAND. Pp. 43. Issued by direction of the Minister of Lands, 1906. The contents include the general instructions to, and general information for, intending applicants for Crown lands, and details of lands available in each district corrected to November 1906. There is a map of each district.

CROWN LANDS GUIDE FOR THE LAND DISTRICTS OF AUCKLAND, TARANAKI, HAWKE'S BAY AND WELLINGTON. Pp. 50. Issued by direction of the Minister of Lands, 1906. The information given is similar to that in the preceding pamphlet, but for the districts mentioned in the title.

West Indies.

BEAUTY SPOTS IN THE WEST INDIES. Issued by Elder, Dempster & Co. A booklet composed of six coloured postcard views of Jamaica, and information about some of the hotels of the Colony.

IMPERIAL DIRECT WEST INDIES SERVICE. Pp. 14. Issued by Elder, Dempster & Co. Information about the steamship service, the attractions of Jamaica, and allied matters.

INDIAN AND COLONIAL COLLECTIONS.

THE NORTHERN NIGERIA COURT.

THE Protectorate of Northern Nigeria, established on January 1, 1900, includes the northern portion of the territories formerly administered by the Royal Niger Company. It is bounded on the south by Southern Nigeria, on the west and north by French possessions (the hinterland of Dahomey and the French Sudan), and on the east by Lake Chad and the German territory of the Cameroons. The area is about 300,000 square miles, and the population in 1904 was estimated at 9,000,000; much higher figures are, however, often given. The general configuration of the country is fairly level, rising from an elevation of 200 to 300 feet at Lokoja, to 1,600 feet at Zaria, and falling again to 450 feet at Lake Chad in the north. Some parts are hilly, and in a portion of the Bauchi Province the mountains rise to over 3,000 feet.

The southern portion of the Protectorate is covered with dense forests especially along the river banks; the central provinces are more open and park-like in appearance, while the extreme north is on the edge of the desert.

There are two well-marked seasons. The wet season, which begins and ends with severe tornadoes, extends from May to October; the rainfall during this period averaging 40 inches. The dry season extends from November to March, and during the whole of this time the Harmattan, a dry wind from the Sahara, blows with varying force.

The highest shade temperature recorded in 1905 was 118° F. at Maifoni in the Bornu Province, and the lowest 39° F. at Kano. The mean temperature of the southern half of the Protectorate is about 82°, the mean maximum being 105°, and the mean minimum 56°.

Northern Nigeria does not extend to the coast, but is physically the hinterland of Southern Nigeria. Idah, on the Niger, close to the boundary between the two countries, is about 200 miles from the sea. The River Niger is the main waterway. A railway is under construction from Baro, the highest point to which the Niger is navigable during the whole year, to Bida, and probably thence to Zaria and Kano. The Lagos railway is also being extended to Jebba, and will probably connect with the above line near Zungeru.

The more important natural products are rubber, palm oil and palm kernels, shea butter, wood oil (West African or Ilorin balsam of copaiba), gum, strophanthus seeds and dye woods. Among the timbers are mahogany and ebony. Tinstone of splendid quality is found in the Bauchi highlands. (*Bulletin of the Imperial Institute*, 1903, **1.** 21.) All the above are exported, as well as ivory, ostrich feathers and tanned skins.

The soil and climate are especially suitable for the cultivation of cotton, which is largely grown by the natives in some parts. Among other products, cultivated mainly for local consumption, are guinea corn, millet, maize, rice, ground nuts, yams, sweet potatoes, okra, sorrel, beans of different sorts, cassava, onions, tomatoes, gourds and peppers (*Capsicum*), tobacco, indigo, and cola nuts. Wheat is also largely grown in the northern parts of the country.

The Northern Nigeria Collection at the Imperial Institute has mainly been brought together by Mr. W. R. Elliott, the Forestry Officer, who collected the majority of the specimens. Other exhibits have been presented by Mr. H. S. N. Edwardes, Mr. E. C. Duff, Dr. Parsons, Mr. C. L. Temple, Captain Fremantle, and Mr. G. C. Dudgeon, Agricultural Superintendent for British West Africa.

VEGETABLE PRODUCTS.

Guinea Corn (*Sorghum vulgare*), "Dawa" (Hausa). This is one of the staple foods of the country. It is cultivated largely throughout the Protectorate, and enormous crops are obtained during the rainy season. A variety known locally as "Mazzagua" or "dry season corn" is grown in Bornu. It is cultivated in drying-up swamps at the commencement of the dry season. (*Bulletin of the Imperial Institute*, 1906, **4**. 226.)

Samples exhibited—

"Dawa" (Guinea Corn), Red variety.
"Dawa" (Guinea Corn), White variety.

Millet (*Pennisetum spicatum*), "Gero" (Hausa). Another of the staple food grains of the country. In the northern parts it takes the place of Guinea corn as the main food of the people. It is cultivated with Guinea corn. An intoxicating drink called "Peto" is made from the fermented grain.

Samples exhibited—

"Gero," *Pennisetum spicatum*.
"Maiwa," *Pennisetum spicatum*, a variety.

Maize (*Zea Mays*). Largely cultivated in the southern parts of the Protectorate. Two crops are obtained during the wet season on the banks of the large rivers, advantage being taken of the rich alluvial soil left as the river falls after having been in flood.

Samples exhibited—

Maize, "Massera" (Hausa).
Maize, "Kabba" (Nupe), "Abaddo" (Yoruba).

Rice (*Oryza sativa*). Cultivated in the riverian provinces, where it is an important article of food.

Samples exhibited—

Rice (husked), "Shinkafa" (Hausa), "Yokofa" (Nupe).
Rice (unhusked), "Shinkafa shanshere" (Hausa).

Wheat (*Triticum vulgare*). The cultivation of wheat is confined to the northern parts of the Protectorate, where it is grown in irrigated fields on the banks of rivers such as the Sokoto River, and the Waube River, which flows along the north of the Bornu province into Lake Chad.

Samples exhibited—

Wheat, "Alkamma" (Hausa), "Shegar" (Beri-beri).
Wheat, grown on banks of Waube River near Yo.

"**Acha**" (*Digitaria* sp. aff. *D. ternata*, Stapf.). A small grass cultivated in the Hausa States and in parts of Bornu. It forms an important article of food. Three or four crops are obtained during the season. The seeds are made into a sort of porridge.

Samples exhibited—

"Acha" (Hausa), "Kasha" (Beri-beri).

"**Tomba**" (*Eleusine coracana*?). Used in same way as "Acha," or eaten raw.

Samples exhibited—

"Tomba" seeds.

Beans. Many varieties are cultivated by the natives and extensively used as food, small balls of ground beans being a constant feature of native markets.

Samples exhibited—

Small White Bean, "Waika" (Hausa).
Small Brown Bean, "Waika" (Hausa).
Large Mottled Bean, "Waika" (Hausa), "Azomunige" (Nupe).
Large Mottled Bean, "Waika."
Ground beans of different sorts, "Wasa wasa" (Hausa), as sold in the native markets.

Ground Nuts (*Arachis hypogea*). Cultivated throughout the country. The nuts are eaten raw or roasted. The oil expressed from the nuts is used largely for cooking. The plant affords valuable fodder during the dry season.

Samples exhibited—

Ground nuts in pod, "Gedda" (Hausa), "Guchia" (Nupe), "Egpa" (Yoruba).
Grounds nuts shelled.

"**Pararu**" (*Voandzeia subterranea*). Cultivated in the same way as the ground nuts, principally by the Nupes. They are known as Bambarra ground nuts.

Samples exhibited—

"Pararu" in pods.
"Pararu" shelled.

Okra (*Hibiscus esculentus*). Cultivated in most parts of the country. The fruits are eaten either green or dried. The young fruits are esteemed as a vegetable in many parts of the tropics, and the roasted seeds have been employed as a coffee substitute.

Samples exhibited—

Dried fruit of Okra, "Kubaiwa" (Hausa).

Sorrel (*Hibiscus Sabdariffa*). Cultivated principally in the northern provinces. The fruits are eaten as a vegetable. Seeds pounded into a meal. In many parts of the tropics a refreshing drink is prepared from the fleshy calyx of the flowers of this plant, which contains, in addition to a red colouring matter, some sugar and vegetable acids.

Samples exhibited—

Fruit of Sorrel, "Yakua" (Hausa), "Masha" (Beri-beri).
Seeds of Sorrel.

Cassava (*Manihot utilissima*). The cassava or manioc is cultivated throughout the Protectorate. The long fleshy tuberous roots (the source of tapioca) are ground into meal and used as a food, and are one of the staples of life of the natives.

Samples exhibited—

Cassava Meal, "Garin Rogo" (Hausa).

"**Efa**," rhizomes of *Mariscus umbellatus*. Eaten raw or roasted.

Samples exhibited—

Rhizomes, "Efa" (Hausa).

"**Epi**," seeds of a gourd. Ground and made into a sort of porridge called locally "Fura."

Samples exhibited—

Seeds of a Gourd, "Epi" (Hausa).

"**Rumena**" (*Gladiolus spicatus*). Bulbs eaten.

Samples exhibited—

Bulbs of *Gladiolus spicatus*, "Rumena" (Hausa).

"**Risga**." Cultivated. Tubers boiled and eaten as a vegetable.

Samples exhibited—

Tubers of "Risga" (Hausa).

"**Dorowa**" (*Parkia filicoidea*). A large leguminous tree common in many parts of the Protectorate. The tree has many uses. The seeds are pounded and made into cakes and sold for food in native markets. The leaves and pods, pounded and mixed with broken stones, form a hard cement. The floors of native huts and the sides of indigo pits are plastered with this. Analyses of the pods have been made at the Imperial Institute, and are recorded in a *Report on Cotton, Gum, and other Economic Products*, [Cd. 2778].

Samples exhibited—

Seeds of "Dorowa" (Hausa), "Elo" (Nupa), "Eru" (Yoruba).

Baobab (*Andansonia digitata*). A common tree, being in some districts the predominant feature in the landscape. The seeds are eaten, being generally pounded into meal and made into cakes. The pulp surrounding the seeds contains free tartaric acid, potassium acid tartrate, and a large quantity of mucilaginous matter. (*Bulletin of the Imperial Institute*, 1906, **4**. 252.)

Samples exhibited—

Meal of Baobab tree, "Garin Kuka" (Hausa).

African Pepper (*Xylopia æthiopica*). The small cylindrical black pods of this tree are very aromatic and pungent, and are used as a flavouring agent. They were formerly in demand in the United Kingdom as a spice, but have now passed out of use.

Samples exhibited—

Pods of *Xylopia æthiopica*, "Kimba" (Hausa), "Chufeni" (Nupe).

Capsicums or **Chillies** (*Capsicum* spp.). These are largely grown and used locally for flavouring. The large trading firms buy and export them.

Samples exhibited—

Small Capsicums from Lokoja.
Small Capsicums from Bida.

Cola Nuts (*Cola acuminata*). Cola nuts are cultivated on a large scale in the southern parts of the Ilorin and Kabba provinces, also in parts of the Nupe province. There are several varieties grown; one, known locally as the "Labogie Nut," is in great demand, and is exported largely to different parts of Northern Africa. Cola nuts are also imported from the Gold Coast and Lagos.

Samples exhibited—

Cola nuts, "Atara," 1st quality.
Cola nuts, "Afata," 2nd quality.
Cola nuts, "Hanna Rua," inferior.

Wild Cola or "**Migin Gora**" (*Sterculia* sp.). The seeds of this plant are used as a stomachic.

Samples exhibited—

Wild Cola Seeds.

Tobacco. This product is largely cultivated and used by the natives throughout the Protectorate. On the banks of the river Kaduna tobacco of quite good quality is grown. It is cultivated there and on the banks of other large rivers in the rich soil left by the rivers when falling after having been in flood. For a full account of the Kaduna River tobacco see *Bulletin of the Imperial Institute*, 1907, **5**. 130.

Samples exhibited—

Tobacco from Bida, as sold in native market.
Tobacco as prepared by the Egbirras, at Kotonkarifi and district.
Tobacco from Waku, in Kwundu district.
Tobacco from the Kaduna. Valued at 4*d*. per lb. in England.
Tobacco from Mariga, Kontagora province.
Tobacco seed from Mariga, Kontagora province.
Tobacco from Share, Ilorin province.

Vegetable Salt. Prepared in the neighbourhood of Lake Chad from the ashes obtained by burning the stems of the salt bush (*Salvadora persica*), known locally as "Kegr or Kighr."

Samples exhibited—

Salt obtained from the salt bush (*Salvadora persica*).
Stems of the salt bush (*Salvadora persica*).

Palm Oil (*Elæis guineensis*). The oil palm, so abundant in West Africa, occurs commonly in Northern Nigeria along the banks of the main rivers. The outer fleshy pulp of the ripe fruits yields the well-known palm oil, of great importance as a local article of food, and also as a commodity for export. The seed or kernel is also largely exported and the palm kernel oil extracted in Europe.

Samples exhibited—

Palm oil.
Palm nuts. The uncracked stones, after removal of the outer fleshy covering.
Palm kernels. Obtained by cracking palm nuts.

Shea Butter. A vegetable fat obtained from the seeds of *Butyrospermum Parkii*, a tree widely distributed throughout tropical Africa, but not usually found in coastal districts, and common in Northern Nigeria.

The fat, obtained by boiling the seeds in water, is used by the natives as an article of food, and as an illuminant. Shea butter is used in the preparation of edible fats and in soap manufacture.

Sample exhibited—

Shea butter.

Ground Nut Oil. From the seeds of *Arachis hypogea.* Used by the natives for cooking purposes.

Sample exhibited—

Ground nut oil.

Balanites ægyptiaca. Oil of Betu Nuts. An oil is obtained from the seeds of this tree, which is common in the Northern provinces. It is estimated by the Resident of Bornu that the available supply is about 600 tons of nuts per annum.

Samples exhibited—

Fruit of *Balanites ægyptiaca*, "Betu" (Beri-beri), "Adua" (Hausa).
Kernels of Betu nuts, "Betu" (Beri-beri), "Adua" (Hausa).
Oil from Betu nuts, "Betu" (Beri-beri), "Adua" (Hausa).

Oil of Ben (*Moringa pterygosperma*). Oil extracted from the seeds of the "horse-radish tree" (*Moringa pterygosperma*). In India, etc., the roots are used as a substitute for horse-radish, but they do not appear to be employed in this way in Northern Nigeria. The seeds yield a limpid oil, which might be used for edible and culinary purposes. (See *Bulletin of the Imperial Institute*, 1904, **2**. 117.)

Samples exhibited—

Seeds of *Moringa pterygosperma.*
Oil from seeds.

Beni Seeds (*Sesamum indicum*). The source of sesame or gingelly oil. The plant is cultivated by the natives, and seeds sold to trading firms for export.

Sample exhibited—

Beni seed.

Wood Oil, or **West African Balsam of Copaiba.** (From *Daniella thurifera.*) A large tree, common in the riverian provinces. The oil is purchased by the trading companies and exported.

Sample exhibited—

Wood oil.

Cotton.

The soil and climate of Northern Nigeria are specially suitable for the cultivation of cotton, which is grown in considerable quantities by the natives. Nearly every village has its field of cotton, and in many places the raw material is manufactured into cloth. A native cotton of very good quality is grown by the Bassa-Komo tribes in the Bassa and Nassarawa provinces. For general information on cotton cultivation in Northern Nigeria see *Bulletin of the Imperial Institute*, 1905, **3**. 49-55.

The specimens enumerated below have been examined in the Scientific and Technical Department of the Imperial Institute, and valued by commercial experts.

Samples exhibited—

Cotton grown from imported seed at Odigbo, Bassa province. Length of staple 0·9–1·4 in. Value about 6*d.* per lb. (with "middling" American at 6·39*d.* per lb.).

Cotton grown from native seed at Odigbo, Bassa province. Length of staple 1·2–1·4 in. Value about 8¼*d.* per lb. (with "good fair" moderately rough Peruvian at 9–10*d.* per lb.).

Cotton grown from imported seed at Abusho, Bassa province. Length of staple 0·8–1·2 in. Value about 6¼*d.* [per lb. (with "middling" American at 6·39*d.* per lb.).

Cotton grown from native seed at Abusho, Bassa province. Length of staple 0·8–1·2 in. Value about 7¾–8*d.* per lb. (with moderately rough Peruvian at 9–10*d.* per lb.).

Cotton grown from native seed at Opanda, Bassa province. Staple 0·9–1·4 in. Value about 8¼–8½*d.* per lb. (with "good fair" moderately rough Peruvian at 9–10*d.* per lb.).

Cotton grown from imported seed at Opanda, Bassa. Staple 0·9–1·3 in. Value 6½–7*d.* per lb. (with "middling" American at 6·39*d.* per lb.).

Cotton grown from imported seed at Kpora, Bassa. Staple 1·0–1·3 in. Value about 6¼*d.* per lb. (with "middling" American at 6·39*d.* per lb.).

Cotton grown from native seed at Kpora, Bassa. Staple 1·0–1·3 in. Value about 8*d.* per lb. (with "good fair" moderately rough Peruvian at 9–10*d.* per lb.).

Cotton grown from native seed at Oketti, Bassa. Staple 1·0–1·3 in. Value 6–6¼*d.* per lb. (with "good fair" moderately rough Peruvian at 9–10*d.* per lb.).

Cotton grown from imported seed at Oketti, Bassa. Staple 0·9–1·2 in. Value 6–6¼*d.* per lb. (with "middling" American at 6·39*d.* per lb.).

Cotton grown from imported seed at Arroa, Bassa. Staple 0·9–1·2 in. Value 7½*d.* per lb. (with "middling" American at 6·39*d.* per lb.).

Cotton grown from native seed at Arroa, Bassa. Staple 0·9–1·3 in. Value 8½*d.* per lb. (with "good fair" moderately rough Peruvian at 9–10*d.* per lb.).

Cotton grown from native seed at Kejeih, Bassa. Staple 1·0–1·3 in. Value 8¼*d.* per lb. (with "good fair" moderately rough Peruvian at 9–10*d.* per lb.).

Cotton grown from imported seed at Kejeih, Bassa. Staple 1·0–1·3 in. Value 6¼*d.* per lb. (with "middling" American at 6·39*d.* per lb.).

Cotton grown from native seed at Roko, Bassa. Staple 1·0–1·4 in. Value 8½–9*d.* per lb. (with "good fair" moderately rough Peruvian at 9–10*d.* per lb.).

Cotton grown from imported seed at Roko, Bassa. Staple 0·9–1·3 in. Value 6*d.* per lb. (with "middling" American at 6·39*d.* per lb.).

Cotton grown from native seed at Agado, Bassa. Staple 0·9–1·3 in. Value 6*d.* per lb. (with "middling" American at 6·39*d.* per lb.).

Cotton grown from imported seed at Agado, Bassa. Staple 1·0–1·3 in. Value 6¼*d.* per lb. (with "middling" American at 6·39*d.* per lb.).

Cotton grown from imported seed at Dekina, Bassa. Staple 1·0–1·4 in. Value 7¼*d.* per lb. (with "middling" American at 6·39*d.* per lb.).

Cotton grown from imported seed at Inegi, Bassa. Staple 1·0–1·3 in. Value 8–8½*d.* per lb. (with "middling" American at 6·39*d.* per lb.).

Cotton grown from native seed at Inegi, Bassa. Staple 0·8–1·2 in. Value 8–8½*d.* per lb. (with "good fair" moderately rough Peruvian at 9–10*d.* per lb.).

Cotton grown from native seed in Yola province. Staple 0·8–1·2 in. Value about 4½*d.* per lb. (with "middling" American at 6·39*d.* per lb.).

Cotton grown from imported seed in the Yola province. Staple 0·9–1·3 in. Value about 6¼*d.* per lb. (with "middling" American at 6·39*d.* per lb.).

Cotton grown from Brazilian seed at Zaria. Staple 0·9–1·3 in. Value about 4*d.* per lb. (with "middling" American at 6·39*d.* per lb.).

Cotton grown from Egyptian seed at Zaria. Staple 0·9–1·5

in. Value about 6*d.* per lb. (with "fully good fair" brown Egyptian at 10*d.* per lb.).

Cotton grown from native seed in Munshi territory. Staple 1·0–1·5 in. Value 8*d.* per lb. (with "good fair" moderately rough Peruvian at 9–10*d.* per lb.).

Cotton grown from imported seed in Ilorin province. Staple 0·9–1·3 in. Value about 6¼*d.* per lb. (with "middling" American at 6·39*d.* per lb.).

Cotton grown from American seed in Nassarawa province.

,,	,,	,,	Native	,,	at Jassol.	
,,	,,	,,	American	,,	,,	Yelwa, Kontagora prov.
,,	,,	,,	,,	,,	,,	Loko, Nassarawa prov.
,,	,,	,,	,,	,,	in Kontagora province.	
,,	,,	,,	Native	,,	,,	,, ,,

Native-made Cotton Yarns, Cloth, etc.

Samples exhibited—

Spool of Yarn as wound by the Egbirras.

Two Spools of Yarn from Bida.

Two Spools of "Wool" as spun by Hausas. "Munzeri" (Hausa).

Reels from Bida.

Robe manufactured in Sokoto. "Zani" (Hausa).

Robe made by Yagbas at Sannu.

Woman's Robe made in Bida.

Robe made by Bennu people in Kukuruku country.

Robe made at Arigiddi in Kukuruku country.

Robe made by Akoko people in Kukuruku country.

Woman's Robe made in Ilorin.

Robe made in Keffi. "Seriki-uku" (Hausa).

Robe made by Yagbas.

Robe made in Bida.

Head Cloth made at Loko. "Fatari" (Hausa).

Head Cloth made at Loko. "Fatari" (Hausa).

Hausa Gown, made in Yola with cotton grown from imported seed. *Presented by the Emir of Yola.*

Strip of cloth made in Yola with cotton grown from native seed.

Strip of cloth made in Yola with cotton grown from imported seed.

Two Reels of Yarn from cotton grown from native seed in Yola.

Two Spools of Yarn from cotton grown from imported seed in Yola.

Cotton Yarn from Bida.
Two Loin Cloths from Bida.
Three Cover Cloths.
One Cap.
Two embroidered pockets for sewing on Gowns.
Seed Extractor (stone slab and iron rod).
Reed Bow for loosening fibres of Cotton.
Native Looms.
Native Shuttles.
Hausa Gown.
Native cotton cloth (blue) used for paying revenue in Kontagora.
Native cotton cloth (white) used for paying revenue in Kontagora.
Native cotton yarn used for paying revenue in Kontagora.

Kapok and Silk Cottons.

Samples exhibited—

Kapok or Silk Cotton (*Eriodendron anfractuosum*).
Silky hairs from seeds of *Funtumia elastica* (the silk rubber tree).

Rubber. A considerable amount of rubber is obtained from Northern Nigeria, mostly from different species of *Landolphia*, *Funtumia elastica* (the Lagos silk rubber tree), and from *Ficus Vogelii.* Methods of collecting are somewhat primitive and destructive.

Samples exhibited—

"A" rubber or White Ball, from *Landolphia owariensis.*
"B" rubber or Brown Medium, from *Landolphia owariensis* and other spp.
"Ire" rubber, from *Funtumia elastica.*
"Balata" rubber, from *Ficus Vogelii.*
"Flake" rubber, from *Landolphia florida* and *Carpodinus hirsutus.*
"Root" rubber, from *Landolphia* spp.
Rubber from Dakka country, Muri province.
"Kano" rubber from *Ficus platyphylla.*
Stem of *Landolphia*, showing native method of tapping.
Stem of *Ficus Vogelii*, showing native method of tapping.

Gums. Large tracts of the Bornu province are covered with gum-yielding species of Acacia, and considerable quantities of gum are collected, sold to the trading firms and exported to the United Kingdom. Nigerian gum closely resembles Senegal gum in quality.

Samples exhibited—

"Kolkol" gum, probably from *Acacia Senegal*, from Bornu.

Acacia gum, probably from *Acacia Senegal*, from Garfang, Kano. Valued at 19/- per cwt. (July 1906).

Acacia gum, probably from *Acacia Senegal*, from Garfang, Kano. Valued at 19/6 per cwt. (July 1906).

Acacia gum, probably from *Acacia Senegal*, from Bornu province. Valued at 23/- per cwt. (July 1906).

Acacia gum, prepared from crude gum produced at Geidam, Bornu. Valued at 28/- per cwt. (July 1906).

Insoluble gum, probably from *Albizzia* spp.

Medicinal Plants and Poisons.

Samples exhibited—

Bark of African Mahogany (*Khaya senegalensis*), used as a stomachic.

Sassy Bark or Sass Wood (*Erythrophlœum guineensis*), "Ordeal Tree," a poison.

Physic Nut (*Jatropha Curcas*), used medicinally (see *Bulletin of the Imperial Institute*, 1904, **2**. 170, for further information regarding this product).

Seed pods of *Strophanthus* spp., arrow poison.

Dyes and Tans.

Samples exhibited—

Camwood. A red dye, still used to a small extent in Europe, especially for dyeing sausage-skins red.

Lonchocarpus cyanescens as sold in market. This material yields indigo identical with that obtained from Indigofera species (see this *Bulletin*, 1907, **5**. 129).

The following materials are of special interest, as they are employed in tanning and dyeing the skins which reach this country as Nigerian or Morocco leather (see below).

Fruiting head and stems of *Sorghum* sp., the stems of which are used as red dye in Kano.

Green "aniline" dye used in dyeing leather.

Ashes of *Butyrospermum Parkii*, burnt for use in dye pits with *Lonchocarpus cyanescens*.

Pods of *Acacia arabica*? Used for tanning leather, Kano.

Fibres.

In Northern Nigeria fibres are prepared by the natives from various plants for local use. No fibres except cotton are exported. A general account of West African fibres is given in *Bulletin of the Imperial Institute*, 1907, **5**. 1 and 107.

Samples exhibited—

Fibre of *Urena lobata*.

Rope made from fibre of *Urena lobata*.

Leaves of Tukurua palm, also known as the "bamboo" or "wine" palm, *Raphia vinifera*.

Covering for loads made from leaves of Tukurua palm.

Fibre of *Hibiscus lunariifolius*.

"Rama" fibre (*Hibiscus lunariifolius?*) ribbons, from Kontagora.

Seedling heads of *Hibiscus lunariifolius*, "Rama."

Rope of Baobab bark.

ANIMAL PRODUCTS.

Skins and Leather. Tanned goat skins are prepared in Northern Nigeria and extensively used locally for various articles of dress, horse equipment, etc. Kano is the centre of the industry. In addition to supplying the local demands, large quantities of skins are carried overland by Arab traders to Tripoli—in fact, Northern Nigeria is one of the original sources of "Morocco leather." It is estimated that this trade amounts to some one million skins annually. The price of the skins in Kano is 7*d*. each.

Samples exhibited—

Tanned Skins prepared at Kano.

Pair of Hausa Mosquito Boots.

"**Munni-Munni.**" A caterpillar, which, when dried, is eaten by the natives.

Samples exhibited—

Dried caterpillars.

MINERAL PRODUCTS.

A Mineral Survey of the Protectorate is now being conducted under the supervision of the Director of the Imperial Institute, and a reference collection of all minerals found is being prepared. The following minerals are shown in the Northern Nigeria Court.

Salt. Brine springs occur at Awe, from which salt can be procured by evaporation. These springs have recently been thoroughly investigated by the officers of the Mineral Survey, and samples of the salt prepared from them are being analysed.

Sample exhibited—

Manga Salt, Nos. 1, 2, 3 and 4. This material is prepared in the Manga district partly from the ashes left by the combustion of plants and partly from salt-impregnated soil. Samples of these products are under examination in the Scientific and Technical Department of the Imperial Institute.

Limestone. Limestone deposits occur in various parts of the Protectorate, but notably at Igbo, and investigations have been made by the Mineral Survey and the Department of Public Works as to its suitability for local use. The Igbo limestone is fairly pure, and suitable for the manufacture of lime and for the preparation of ordinary mortar.

Samples exhibited—

Igbo Limestone—good quality.
Igbo Limestone—poor quality.

Tinstone.—Specimens of the tinstone found in the Bauchi Province and of tin smelted from it are shown. For analyses of Nigerian tinstone, see *Bulletin of the Imperial Institute*, 1903, **1.** 21.

NATIVE ARTICLES, ETC.

Hausa Knife and Sheath.
Waist-belt made of discs of Coconut shell.
"Grass" Cloth, made of Raphia fibre with strengthening threads of Cotton yarn.
Necklace of Limestone and Agate beads.
Wooden Arm Bangle.
Stone Arm Bangle.
Goat-skin Snuff Bottle.
Native Razor.
Needle for sewing on Thatch.
Cotton Loom.
Shuttle.
Brass Basin, characteristic of Bida brassware.
Brass Water Ewers, characteristic of Bida brassware.
Hausa Spears.
Horseman's Shield, made of Hippopotamus hide.
Nupe Mat.
Native Mats, used for covering calabashes containing milk, etc.
Hausa Hat.
Photographs.
Horse Trappings.
Ornamental Scarf.
Native-made Slippers.
Snares for catching Guinea Fowl.
Small Tin Canister.
Small Ornamental Gourd.
Grass Bracelet.
Young Girl's Apron (iron beads).
Metal Necklace and Charms.
Blue Cloth.
Native Skull Cap.

Baby's Rattle.
Traps for large Game.
Spindle for winding Cotton.
Loofa.
Hair Pins.
Bells used in Dancing.
Bead and Cowrie Necklace.
Photographs.
Wooden tablet with extracts from the Koran in Arabic characters, as used in native schools in Kano.
Native Mat.

LIBRARY.—RECENT ADDITIONS.

Books, etc., exclusive of Government Publications, presented to the Library of the Imperial Institute since June 17, 1907.

New Canada and the New Canadians .	By Howard Angus Kennedy. (*Messrs. Horace Marshall & Co.*)
Year-Book of the Livingstone College, 1907	(*The Principal.*)
Journal of the Mining Society of Nova Scotia, Vol. x. Being the Transactions of the Society during the year 1905–1906	(*The Secretary.*)
Report of the South African Association for the Advancement of Science. Third Meeting, Johannesburg, 1905. Fourth Meeting, Kimberley, 1906 . . .	(*The Secretary.*)
Handbook of Agriculture, with special reference to the requirements of South Africa	By the late Professor Blersch. (*Messrs. J. C. Juta & Co.*)
"The Harp," original poems . . .	By John Temple Trotman. (*The Author.*)
The Handbook of Jamaica for 1907 .	By Jos. C. Ford and Frank Cundall, F.S.A. (*The Crown Agents for the Colonies.*)
Proceedings of the Rhodesia Scientific Association, Vol. vi., Part ii., 1907 .	(*The Secretary.*)
Annual Report of the Council of the City and Guilds of London Institute, 1907 .	(*The Hon. Secretary.*)
Southport: Official Guide of the Corporation	(*The Town Clerk.*)
Annali di Agricoltura, 1907 . . .	(*The Secretary, Department of Agriculture, Rome.*)

Sand and Clay: their Analysis and Physical Properties	By Augustine C. Passmore. (*The Technical Publishing Company.*)
Le Cocotier	By Paul Hubert. (*MM. H. Dunod and E. Pinat.*)
Modern Flax, Hemp and Jute Spinning and Twisting	By Herbert R. Carter. (*Messrs. Scott, Greenwood & Sons.*)
A Tour over the Pioneer Railway of Canada (The Grand Trunk Railway)	By John Wardle. (*The Railway Publishing Company.*)
How to Use Water Power	By Herbert Chatley, B.Sc. (*The Technical Publishing Company.*)
Report of the Bombay Chamber of Commerce, 1906	(*The Secretary.*)
Report of the Karachi Chamber of Commerce, 1906	(*The Secretary.*)
Proceedings of the Royal Colonial Institute, Vol. xxxviii. 1906–1907	(*The Secretary.*)
Report of the Bengal Chamber of Commerce, 1906. Vol. i.	(*The Secretary.*)
Green Manuring in Tea Culture in India The Blister Blight of Tea The Treatment of Deteriorated Tea The "Red Slug" Caterpillar The Tea Soils of Cachar and Sylhet The Fermentation of Tea, Part ii. The "Mosquito Blight of Tea," Parts i., ii., and iii.	By Harold H. Mann, D.Sc. (*The Indian Tea Association.*)
Canada's Century: Progress and Resources of the Great Dominion	By R. J. Barrett, F.R.G.S. (*The Author.*)
Modern Argentina	By W. H. Koebel. (*Mr. Francis Griffiths.*)
Kaffee, Kaffeekonserven und Kaffeesurrogate	By E. Franke. (*Herrn A. Hartleben.*)
The Institute of Chartered Accountants in England and Wales: List of Members, Royal Charter and Bye-laws, 1907	(*The Secretary.*)

Anglo-Russian Literary Society: Proceedings May, June and July, 1907 . (*The Secretary.*)
Tuiles Vegetales . . . . . } By E. de Wildeman.
Emile Laurent: Esquisse Biographique . } (*The Author.*)
The National Fruit and Cider Institute: Its Origin and Objects . . . By A. E. Brooke-Hunt.
The National Fruit and Cider Institute Annual Reports for 1904–1905, 1905–1906, 1906–1907 . . . . . (*The Director.*)
Documentary History of Education in Upper Canada, Vol. xvii., 1861–1863 . By J. George Hodgins, I.S.O., M.A., LL.D.
(*The Author.*)
New Zealand University Calendar, 1906–1907 . . . . (*The Registrar.*)
Theobroma Cacao or Cocoa, its Botany, Cultivation, Chemistry and Diseases . By Herbert Wright.
(*Messrs. A. M. & J. Ferguson.*)
The Relation of Desert Plants to Soil Moisture and to Evaporation . . By B. E. Livingston.
(*The Carnegie Institution.*)
Annual Report of the Adelaide (South Australia) Chamber of Commerce, 1907 . . . . (*The Secretary.*)
The Weeds and Suspected Poisonous Plants of Queensland . . . By F. Manson Bailey, F.L.S.
(*The Author.*)
Materials for a Flora of the Malayan Peninsula, Parts i. and ii. . . . By H. N. Ridley, M.A., F.R.S., F.L.S., F.R.H.S.
(*The Author.*)
The Tasmanian Post Office Directory (Wise's) for 1907 . . . . . (*Wise's Directories.*)
Report of the Vancouver Board of Trade, 1906–1907 . . . . . . (*The Secretary.*)
Practical Coal Mining, Vol. iii. . . (*The Gresham Publishing Company.*)
Calendar of Letter Books of the City of London at the Guild Hall. Letter Book H. Circa A.D. 1375–1399 . By Reginald R. Sharpe, D.C.L.
(*The Town Clerk.*)
The Ears as a Race-character in the African Elephant . . . . By R. Lydekker.
(*The Author.*)

BULLETIN

OF THE

IMPERIAL INSTITUTE

1907. Vol. V. No. 4.

SCIENTIFIC AND TECHNICAL DEPARTMENT.

RECENT INVESTIGATIONS.

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Indian and Colonial Governments concerned.

TANNING MATERIALS FROM INDIA, THE COLONIES, AND OTHER SOURCES.

DURING the last few years a large number of tanning materials have been received at the Imperial Institute for examination from various Colonies and Protectorates. A few of these are rich enough in tannin to be worth consideration for importation into the United Kingdom for use by tanners, but the majority are only likely to be of local interest in the countries in which they are produced, since they are comparatively poor in tannin and do not possess any special qualities likely to commend them to the notice of European tanners. Even these products are, however, of some general interest, since in many of the Colonies and Protectorates attention is now being devoted to the development of native tanning industries with a view to the production of leather suitable for importation into the United Kingdom, and for this reason samples of the tanning materials available in several of the Protectorates have been submitted for examination to the Imperial Institute so that the best of these could be selected for use.

In this article the results secured by the examination of a number of these products are given. It should be noted that in September of the present year a new method of estimating tannin in tanning materials was formally adopted by the International Association of Leather Trades Chemists, a body which has accomplished much useful work in securing uniformity in methods of analysing tanning materials. Most of the analyses now recorded were made by the older hide powder filter process before the adoption of this new method. Determinations made by the new process are indicated in the results given below by an asterisk placed after the tannin percentage.

Most of the tanning materials have been examined in the laboratories of the Scientific and Technical Department of the Imperial Institute, and in cases where the material seemed likely to be worth exporting to this country, or was otherwise of special interest, samples have been submitted to experts for technical trial and commercial valuation.

MANGROVE BARKS.

Reference has been made already in this *Bulletin* (1905, **3**. 345) to this cheap tanning material which is obtainable in large quantities from many tropical countries, and a full account has been given of the sources of this product and the methods of utilising it. The increasing demand for mangrove bark, especially on the Continent, has stimulated interest in it in many of the tropical Colonies and Protectorates, and as a result a number of samples of the bark have been received for examination recently.

British Honduras.

Four samples of the mangrove barks obtainable in this Colony were received last year. These were described as follows :—

"Red mangrove from *Rhizophora Mangle.*" This sample consisted of large quills and flat pieces, which were dull orange-red in colour and hard and tough : the inner surface of the bark was very fibrous and the cross-section of the bark showed the small white spots, which are characteristic of mangrove bark derived from this species.

"White mangrove bark from *Laguncularia racemosa*." This consisted of thin papery bark of light-brown colour. It split readily into two portions; an inner smooth layer and a rougher outer layer of rather darker colour. A few of the pieces had a small quantity of a dark-brown scale adhering to them.

"Zaragoza mangrove from *Conocarpus erectus*." This sample was composed of flat strips of rather fibrous bark showing a tendency to split into several layers. The outer surface was dark brown with silvery patches, and the inner surface was pale reddish-brown, usually with small fragments of wood adhering to it.

"Black mangrove bark from *Avicennia nitida*." This consisted of rounded pieces of bark, about two inches in diameter. The bark was very dark coloured, almost black internally, and was rough both on the inner and outer surfaces.

The results of the chemical analyses of these four barks were as follows:—

	Red mangrove bark.	White mangrove bark.	Zaragoza mangrove bark.	Black mangrove bark.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture . . .	11·6	12·0	16·0	11·4
Tannin	20·2	12·3	18·7	5·4
Extractive matter (non-tannin) .	11·0	6·0	3·6	7·5
Nature of leather produced.	Firm, but rather harsh and pale red.	Excellent and similar in quality to that produced by oak bark.	Yields a better leather than the red mangrove.	Poor and imperfectly tanned.

From a consideration of the results given above, the expert who examined the samples concluded that all these barks were too poor in tannin to be worth consideration for export purposes, since the best of them, viz. the white mangrove bark, would at present rates only fetch £3 per ton in this market. It would, however, be an excellent material for local use as a tanning agent, whilst the "red" and "Zaragoza" barks would also be suitable for local use. It was further pointed out that the white bark would probably make an excellent tanning extract, which would sell readily in this country if the good colour and weight-giving qualities characteristic of the bark

were retained in the extract. The red and Zaragoza barks it was thought would yield extracts of fair quality. The black mangrove bark was regarded as of no value even for local use.

British Guiana.

A sample of bark derived from *Rhizophora Mangle* was received from this Colony in May 1906. It consisted of thick dark reddish-brown bark, which was of dense structure, contained very little fibre and was readily ground to a dark-red powder.

On analysis it gave the following results :—

	Per cent.
Moisture	15·9
Ash	5·5
Tannin	25·0
Extractive matter (non-tannin)	6·4

The bark yielded a medium reddish-brown leather of the kind furnished by typical mangrove barks of commerce.

As this mangrove bark contains only 25 per cent. of tannin, it is not rich enough to be worth exporting to Europe, but it would answer well for local use and would probably yield a satisfactory mangrove extract.

West Africa.

Enormous forests of mangroves occur along the coasts of the West African Colonies and Protectorates, and in the article already quoted (this *Bulletin* 1905, **3**. 345) it was mentioned that attempts had been made from time to time to utilise these as sources of supply, but the attempts have been unsuccessful, either, as in Senegal, owing to restrictive legislation to prevent erosion of the foreshore, which frequently follows the destruction of mangroves, or as in the British Colonies, where it is alleged that the production of palm oil and other products is so much more remunerative that there is no incentive to collect such materials as mangrove barks. It has also been stated that the high freight rates prevailing in West African trade render the export of mangrove bark, which does not as a rule bring more than £4 10*s*. to £5 per ton, unremunerative.

Sierra Leone.—A sample of red mangrove bark was received

from the Governor of this Colony in July of last year. It consisted of thick pieces of red bark showing the characteristic structure and appearance of the mangrove bark of commerce.

On analysis it was found to contain only 18 per cent. of tannin. It appeared possible that this low percentage of tannin might be due to the bark having been exposed to rain after collection, but from information received from the Governor of the Colony it appears that small shipments of this bark made by private traders had proved unsaleable, so that it seems possible that the bark of this species is poor in tannin, at any rate as produced in Sierra Leone.

Gambia.—A sample of mangrove bark of unknown botanical origin was received from Gambia in February of this year. It consisted of small pieces of pale reddish, rather brittle bark, which was thinner than the typical bark of commerce and was covered in some parts with a thin layer of darker-coloured external bark.

On analysis it gave the following results :—

	Per cent.
Moisture	10·8
Ash	2·9
Tannin *	25·7
Extractive matter (non-tannin)	12·4

It yields with calf-skin a soft leather of good grain and unusually good colour for mangrove bark. The bark is probably too poor in tannin to be sold in the United Kingdom at rates which will be remunerative to exporters, but this point is at present still under investigation. It would probably be an excellent material for the manufacture of mangrove extract.

Gold Coast Colony.—A sample of mangrove bark from this Colony was received in July last. The botanical origin was not stated.

The bark was thick, dark red in colour, and the cross-section showed the white spots characteristic of some varieties of mangrove bark.

On analysis it was found to contain 29 per cent. of tannin.

Leather tanned with it was dark red in colour and rather harsh. Such bark would be practically unsaleable in the United Kingdom.

Portuguese East Africa.

This Portuguese Colony, as is well known, is one of the principal sources from which the mangrove bark of commerce is derived (compare this *Bulletin* 1905, **3**. 352 and 1907, **5**. 59), and it is of interest therefore to mention for comparison the results obtained by the analysis of three samples of bark received recently from this source.

No information was supplied as to the botanical origin of the samples.

No. 1 consisted of very fibrous reddish-brown bark covered with a smooth light-coloured outer layer, which amounted to 4 per cent. by weight of the whole bark. This sample was apparently derived from branches or from the stem of a comparatively young tree.

No. 2 was composed of fairly large pieces of rather brittle deep red-coloured inner bark, covered with a thick rough dark-coloured outer bark, which amounted to about one-third of the whole.

No. 3 consisted of small pieces of reddish-coloured fibrous inner bark, covered with a rough dark outer bark amounting to about 33 per cent. of the whole.

On analysis these samples gave the following results:—

	Sample No. 1.		Sample No. 2.			Sample No. 3.
	Whole bark.		Whole bark.	Inner bark.	Outer bark.	Whole bark.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	9·89	10·8	11·3	13·22	12·69	13·53
Ash	3·98	—	—	3·47	2·04	3·64
Tannin *	23·3	24·2	28·3	39·8	8·97	41·76
Extractive matter (non-tannin)	9·1	7·6	10·6	10·6	5·93	7·20

All three samples yield reddish-brown leathers having the usual characteristics of leather tanned with mangrove bark. Of

* *The figures quoted in the second and third columns were supplied with the samples as the results of previous analyses.*

the three barks No. 3 alone contains sufficient tannin to be worth export in the crude condition; but it is clear from the results given in the columns 3, 4 and 5 of the table that sample No. 2, if properly scraped free from outer bark, would yield bark of marketable quality. The sample of No. 1 was too small to permit of separate analyses of the outer and inner barks being made; but in this case the inner bark is unlikely to be of marketable quality, as the whole bark contains only four per cent. of outer bark removable by scraping.

Seychelles.

During the last year some attention has been given to the utilisation of the mangrove forests in these islands, and some consignments of bark from the Seychelles have been sold already in this country. The principal mangroves available there are *Rhizophora mucronata*, *Bruguiera gymnorrhiza*, *Ceriops Candolleana*, *Avicennia officinalis* and *Pemphis acidula*, and samples of bark from all these species have been submitted recently for examination and commercial valuation. The results of the chemical examination of the barks are given in the following tables :—

Bark from *Rhizophora mucronata.*

	Bark from old roots.	Bark from young roots.	Bark from old stems.	Bark from young stems.	Bark from old branches.	Bark from young branches.	Scrapings from stem bark of old Rhizophora.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture . . .	10·92	13·00	11·46	12·31	12·48	14·40	12·11
Ash	5·04	8·47	5·85	6·00	4·58	5·34	1·05
Tannin	33·90	17·77	35·04	29·71	34·50	25·50	6·27
Extractive matter (non-tannin). .	12·50	16·68	9·00	11·91	11·50	15·72	3·00

Bark from *Bruguiera gymnorrhiza.*

	Bark from branches.	Bark from stems.	Scrapings from branch bark.
	Per cent.	*Per cent.*	*Per cent.*
Moisture	13·79	11·75	13·72
Ash	4·21	4·32	1·60
Tannin	41·76	45·04	7·50
Extractive matter (non-tannin) . . .	9·04	10·66	4·33

Bark from *Ceriops Candolleana.*

	Bark from stems.	Bark from branches.	Scrapings from stem bark.	Scrapings from branch bark.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	10·58	11·89	8·78	9·61
Ash	4·75	3·94	6·62	8·00
Tannin	35·00	34·82	14·60	13·23
Extractive matter (non-tannin)	12·77	10·18	11·63	10·33

Bark from *Avicennia officinalis.*

This contained only 3·50 per cent. of tannin and 15·70 per cent. of non-tannin extractive matter, and is therefore of no value as a tanning agent. In this respect it resembles the bark from the closely related *Avicennia nitida* of British Honduras (see p. 345), which contains only 5·4 per cent. of tannin and cannot be used as a tanning material.

Bark from *Pemphis acidula.*

	Bark from stems.	Scrapings from stem bark.
	Per cent.	*Per cent.*
Moisture	12·06	12·45
Ash	6·73	5·94
Tannin	42·54	19·98
Extractive matter (non-tannin)	9·36	3·75

Leaving out of account the bark of *Avicennia officinalis* it will be seen that out of the four sets of Seychelles mangrove barks examined, that prepared from *Bruguiera gymnorrhiza* is the richest in tannin, that from *Pemphis acidula* coming next. Both these contain over 40 per cent. of tannin, and would therefore be readily saleable in this country. The two sets of barks derived from *Rhizophora mucronata* and *Ceriops Candolleana* contain from 25 to 35 per cent. of tannin, and these results are rather disappointing, since in East Africa the barks from these two species are said to contain over 40 per cent. of tannin. At present it is scarcely possible to sell mangrove bark of ordinary quality containing less than 40 per cent. of tannin at remunerative rates, so that under the prevailing conditions it appears likely that of the Seychelles barks only those of *Bruguiera gymnorrhiza* and *Pemphis acidula* can be sold in the

form of bark. The barks derived from *Rhizophora mucronata* and *Ceriops Candolleana* could however be used in the Seychelles for the manufacture of mangrove extract.

As regards the quality of the leather obtained by the use of these Seychelles barks, there is little to choose between the four. The leather produced is characteristically reddish in colour in all four cases, but that produced by the bark of *Pemphis acidula* is a trifle darker than those from the other three.

The results of these analyses enable some conclusions to be drawn regarding the collection and preparation of the mangrove bark for the market. Table I. shows that the richest bark is obtainable from the *old* branches, stems or roots, that from the stems of young trees or from young branches containing much less tannin. Further it is clear that, at any rate where labour is not very costly, it is desirable to remove the external layers of bark before export, since the "scrapings" so removed contain but little tannin, and when not removed add unnecessarily to the cost of freight, and lower the tannin content of the bark as a whole. This point has been referred to already in connection with the Portuguese East African samples (p. 349). The first three tables also indicate that stem bark is usually richer in tannin than bark from branches, and in the case of *Bruguiera gymnorrhiza* bark it might be worth while to export stem and branch bark separately.

The mangrove bark so far exported from the Seychelles has been, it is stated, entirely of the *Bruguiera* variety, and has realised on the average about £4 15*s*. per ton.

India.

In 1899 a series of mangrove barks and extracts from India was examined, and the results, which are recorded in "Technical Reports and Scientific Papers," published by the Imperial Institute in 1902, show that on the whole the Indian mangrove barks are poor in tannin and could best be utilised by conversion into tanning extracts. Recently a sample of extract prepared from the bark of *Rhizophora mucronata* has been received at the Imperial Institute for examination. It contained 57·2 per cent. of tannin and was almost completely soluble in water. It gave a rather dark-coloured leather, and was on this

account of inferior quality. There can however be but little doubt that with care mangrove extract of good quality can be prepared from several of the Indian mangrove barks.

WATTLE OR MIMOSA BARKS.

At the present time European supplies of these tanning barks are derived mainly from Natal and Australia, and though several of the species of mimosa specially cultivated for tanning bark have been acclimatised in India, German East Africa and elsewhere, no commercial supplies are at present derived from these sources. In the beginning of the present year the Imperial Institute received from the Trades Commissioner for the Cape of Good Hope a series of samples of barks derived from *Acacia* trees indigenous to, or introduced into the Colony, with a request that they might be examined, and their value as tanning agents ascertained.

These samples have been chemically examined and have given the following results:—

	1 *Acacia pycnantha* bark.	2 *Acacia decurrens* bark.	3 *Acacia decurrens* bark.	4 *Acacia saligna* bark.	5 Mimosa bark.	6 *Acacia horrida* bark.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture . . .	10·14	11·36	10·93	11·11	12·39	10·97
Ash	1·54	1·77	1·81	4·02	5·35	4·53
Tannin	40·09	35·36	44·15	26·38	18·00	18·28
Extractive matter (non-tannin) .	13·00	12·00	7·12	12·12	7·54	8·31

Of these six barks the first is identical with the "golden wattle bark" of South Australia, the second and third are derived from the "black wattle" largely cultivated in Natal, whilst the last three are from species indigenous to Cape Colony.

The first three barks are of good quality, rich in tannin, and yield leathers similar in character to those obtained by the use of Natal and Australian wattle barks. The samples were valued by brokers at £6 10*s.* to £7 10*s.* per ton. These prices are slightly lower than those obtained for Natal barks, probably because the Cape specimens were small and not well prepared, and better prices might be realised in time if these barks were placed on this market in quantity.

The other three samples (Nos. 4, 5 and 6 in the table) are too poor in tannin to be worth consideration for export purposes, since they possess no special qualities likely to commend them to European tanners. The *Acacia saligna* bark (No. 4) yields a nicely fawn-coloured but rather brittle leather, and the bark of *Acacia horrida* (No. 6) a bright-brown leather with a dull surface and rather brittle. Sample No. 5, the botanical origin of which was not given, resembles the bark of *Acacia horrida* in properties, and is possibly also derived from that species. These three barks would make satisfactory tanning materials for local use.

VARIOUS TANNING MATERIALS.

South Africa.

Included with the mimosa barks from Cape Colony, referred to above, were three unidentified barks, to which reference may also be made.

No. 1. "*Krupelhout.*"—This consisted of small pieces of thin bark having a smooth dark outer surface and an inner pale reddish, fibrous and reticulated surface.

No. 2. "*Kliphout.*"—This sample was composed of quills of bark about 0·25 inch thick and showing a rough dark outer surface with yellow spots and a smooth striated inner surface of terra-cotta colour.

No. 3.—This specimen was unnamed, and consisted of long hollow cylindrical pieces of thick bark covered with bright orange-yellow scales.

On analysis these barks yielded the following results :—

	No. 1. *Per cent.*	No. 2. *Per cent.*	No. 3. *Per cent.*
Moisture	10·22	10·47	11·02
Ash	0·97	2·82	10·47
Tannin	18·75	32·97	17·27
Extractive matter (non-tannin)	8·00	15·12	10·27

Of these three barks No. 1 produces a bright red leather similar in type to that furnished by mangrove bark. No. 2 is rich in tannin and yields a slightly brittle leather resembling that yielded by the bark of *Acacia saligna*, but lighter and brighter in colour. No. 3 yields a dull dark-brown soft leather. Sample

No. 2 is the only one of these three barks which is possibly worth consideration for export purposes, and would be worth further investigation and trial on a large scale.

"*Cape Sumach.*"—This material consists of the leaves and stems of *Osyris compressa* (*Colpoon compressum*). The name "Cape Sumach" is misleading, since the product is quite different from true sumach, which consists of the leaves of the South European plant *Rhus coriaria.*

Two samples of Cape Sumach have been received recently at the Imperial Institute for examination; one from the Transvaal and the other from Cape Colony.

The samples have been chemically examined and have given the following results:—

	Transvaal Sample. *Per cent.*		Cape Colony Sample. *Per cent.*
	Stems.	*Leaves.*	
Moisture	11·2	11·2	11·19
Ash	—	—	5·19
Tannin	12·9	13·6	19·94
Extractive matter (non-tannin)	14·6	21·4	28·27

It will be seen that the two samples differ considerably in composition, that from Cape Colony being much the richer in tannin, though even this sample appears to be below the average in tannin, since previous investigators have found as much as 26 per cent. of tannin in samples of "Cape Sumach." The expert who examined the Transvaal sample stated that it yielded a spongy, porous leather, and was quite devoid of the lightening and scouring properties, which are characteristic of true sumach. These remarks apply equally well to the sample from Cape Colony. Though "Cape Sumach" is of no value for export purposes, it would be a useful tanning agent for local use.

Uganda.

There is a local industry of some importance in this Protectorate in the tanning of skins and hides, for which purpose barks imported from East Africa and India are used in addition to certain tanning materials obtained from indigenous plants.

"*Busana*" *bark.*—The botanical origin of this bark is not

known with certainty, but it is derived from an *Acacia* near *A. spirocarpa.* It is used by tanners in the neighbourhood of Entebbe, and two samples of it have been sent to the Imperial Institute recently for examination by the officer in charge of the Botanical and Forestry Department.

The samples consisted of small pieces of bark, which is light-coloured and fibrous on the inner surface and dark-brown on the outer surface. The first sample on analysis proved to contain scarcely any tannin, but the second sample gave the following results:—

	Second Sample. *Per cent.*
Moisture	9·61
Ash	4·29
Tannin *	10·37
Extractive matter (non-tannin)	5·26

It will be seen that the bark shows some variation in the amount of tannin it contains. It tans very slowly, producing a pale brown-coloured leather which is rather harsh and somewhat brittle. It is too poor in tannin to be worth export, but is a fairly satisfactory material for local use, especially if employed in conjunction with the better materials imported from India.

"*Mukunyu*" *bark.*—The botanical origin of this material is uncertain, but from the examination at Kew of imperfect botanical specimens of the plant yielding it, it appears probable that the bark comes from a *Ficus* closely allied to *Ficus corylifolia.* The sample received consisted of reddish-brown bark partially ground and ready for use by the tanner. It yielded to water a pale reddish-brown extract, and was found to contain only 2·1 per cent. of tannin, and is therefore of little value for tanning purposes. It is possible however that this sample like the first sample of "busana" bark received is abnormal, and contains less tannin than the "mukunyu" bark generally available.

Terminalia velutina bark.—This is one of the new plants discovered by Mr. Dawe, officer in charge of the Botanical and Forestry Department of Uganda, in the Protectorate. It was first found near Unyoro in 1905, and has been observed recently in abundance in the Chagwe district near the Mabira Forest. As it is closely related to several plants, which in India yield

valuable tanning materials, it seemed likely that the bark might be of value for this purpose.

The sample consisted of small pieces of bark from 0·25 to 0·5 inch thick, showing a smooth light-brown inner surface and a rough dark-brown outer surface.

On analysis it gave the following results :—

	Per cent.
Moisture	10·0
Ash	11·5
Tannin*	13·7
Extractive matter (non-tannin)	4·6

The bark produces a rather dark-brown leather of firm texture. It is not very rich in tannin, but is quite suitable for local use, especially in conjunction with a lighter coloured and better tanning material such as the bark of *Cassia auriculata* imported into Uganda from India for use by native tanners.

Terminalia Spekei fruits.—This material is of special interest, since it is obtained from a plant nearly allied to those from which the well-known Indian tanning material, myrobolans, is derived.

A sample of the fruits was sent to the Imperial Institute by Mr. Dawe in the beginning of this year. It consisted of winged fruits, which were dark brown internally and pale yellow and somewhat soft externally.

The sample on examination gave the following results :—

	Per cent.
Moisture	9·7
Tannin	8·2
Extractive matter (non-tannin)	5·6

The aqueous extract prepared from the fruits was very dark coloured, and the material was regarded as of little value as a tanning agent.

Somaliland.

Samples of several of the tanning materials used by the Somalis have been forwarded from time to time since 1904 by Dr. Drake-Brockman for examination, and two of them are of

some interest in being derived from species closely allied to plants yielding better-known tanning materials.

"*Watta*" *leaves*.—These are obtained from *Osyris abyssinica*, a near relative of the plant yielding "Cape Sumach" (see p. 354). The samples consisted of small, dry, brittle, green to greenish-brown leaves. The first of the two samples received contained a considerable amount of twigs, but the second sample consisted almost entirely of leaves. On chemical examination these samples yielded the following results :—

	First Sample. *Per cent.*	Second Sample. *Per cent.*
Moisture	11·0	10·3
Ash	7·1	5·4
Tannin	23·3	24·8
Extractive matter (non-tannin)	13·2	11·8

The leaves yield a light-brown leather of fair quality.

"*Gallol*" *root-bark*.—This material is obtained from an acacia allied to *Acacia latronum*, a species belonging to a genus from which a number of tanning materials are derived.

The sample consisted of thin pieces of tough, fibrous, light-coloured bark. On analysis it gave the following results :—

	Per cent.
Moisture	12·0
Ash	4·6
Tannin	24·0
Extractive matter (non-tannin)	7·7

The tannin in this bark is readily soluble in water and produces a pale pink-tinted leather of good texture.

"*Marra*" *bark*.—The botanical origin of this product is not known. The sample consisted of small thin pieces of tough, very fibrous bark of light-greyish brown colour with some green patches. On analysis it gave the following results :—

	Per cent.
Moisture	10·4
Ash	3·6
Tannin	13·7
Extractive matter (non-tannin)	13·7

The bark furnishes a medium brown-coloured leather which is rather harsh and stiff.

The best of these three Somaliland tanning materials is "Watta" leaves, which contains about 24 per cent. of tannin. "Gallol" is about equally rich in tannin, but yields a darker-coloured leather. "Marra" bark is inferior to the two foregoing, and the Somalis rarely use it alone for tanning, the mixture in general use being "Marra" and "Gallol" barks. None of these materials is suitable for export purposes, as although the first two are fairly rich in tannin they possess no special properties which would enable them to compete with tanning materials already on the market in this country.

Sudan.

Reference has already been made in this *Bulletin* (1906, **4**. 95) to a number of the principal tanning materials in use among the natives in the Sudan, and results are given of the analyses of "Sant" bark and "Sant" pods (the bark and fruits of *Acacia arabica*), "Mudus" bark (*Parkia filicoidea*), and "Abu Surug" bark (*Prosopis oblonga*).

"*Sant*" *bark.*—It was pointed out in the former article that the sample of "Sant" bark then dealt with contained less tannin than that usually found in the Indian bark of this species, and that in addition it was darker coloured. A second sample of this bark was received from the Agent for the Sudan in 1906.

It consisted of medium-sized quills of bark, which was thinner than the average Indian bark. The outer surface was smooth and dark brown, and showed a purplish sheen with occasional green patches. The inner surface was uniformly pale brown in colour. On analysis the sample gave the following results; those furnished by the former sample are added for comparison.

	First Sample. *Per cent.*	Second Sample. *Per cent.*
Moisture	11·5	12·4
Tannin	8·8	17·8
Extractive matter (non-tannin)	4·0	11·0

It will be seen that the second sample is much superior to the former one in the amount of tannin it contains, and differs but

little in this respect from the average Indian "babul" bark. Like the latter also it yields a fawn-coloured leather of good quality, whereas the first sample yielded a dark-coloured, rather harsh leather.

Ximenia americana bark.—A sample of this tanning material, which bears the native name "alimu," was received from the Secretary to the Central Economic Board, Khartum, in December 1906. It consisted of small pieces of reddish-brown bark, which was rather fibrous and covered with a rough, dark-coloured scale. On analysis it gave the following results :—

	Per cent.
Moisture	9·77
Ash	6·70
Tannin	16·9
Extractive matter (non-tannin)	6·0

The bark furnishes a soft leather with a rather reddish colour.

"*Kili*" *bark.*—This material is derived from a species of *Ficus.* The sample, received from the Secretary to the Central Economic Board, Khartum, in December 1906, consisted of portions of bark from 5 to 6 inches in length. The outer surface was light coloured and smooth and the inner surface reddish brown. The following results were obtained on analysis :—

	Per cent.
Moisture	10·97
Ash	13·87
Tannin	18·95
Extractive matter (non-tannin)	4·25

The leather produced by the bark is deep reddish brown in colour and very harsh, and inferior to that obtained by the use of either "Sant" bark or the bark of *Ximenia americana.*

None of these Sudanese tanning materials is suitable for export purposes. The present value of oak bark of fair quality is about £2 10*s.* per ton, and "Sant" bark might fetch about this price, since though it is richer in tannin it produces leather inferior in colour and texture to that obtained with oak bark. It is obvious that such a price would not cover the cost of collection

in and transport from the Sudan. The value of *Ximenia americana* bark would be less. Both barks are however suitable for local use, and if the manufacture of tanning extracts is undertaken at any time in the Sudan, "Sant" bark especially would appear to be a promising material as a source of extract.

"BARBATIMAO" BARK FROM BRAZIL.

The Imperial Institute receives from time to time from British Consuls in foreign countries, for examination, samples of natural products likely to be of interest to manufacturers in this country or which are worth consideration as possibly suitable for production in British Colonies. Among the materials received in this way recently was a sample of barbatimao bark sent by the Consul-General at Rio de Janeiro with the information that it was obtainable in considerable quantity in Brazil, where it is much used as a tanning material. The bark is derived from *Stryphnodendron Barbatimam*, and does not appear to be well known in Europe, although it was examined in 1886 by a Russian pharmacist named Wilbussewitcz, who found that it contained 27·8 per cent. of tannin. The sample received at the Imperial Institute consisted of rounded quills of bark, showing a well-marked division into two layers. The outer layer consisted of dark-red, brittle, porous bark, which showed a tendency to break up into cubical pieces. The inner portion was a pale-coloured, tough, fibrous layer, which could be peeled off readily. On analysis it gave the following results:—

	Per cent.
Moisture	13·5
Tannin	27·8
Extractive matter (non-tannin) . .	5·2

The aqueous extract obtained from the bark is of good colour and is comparatively strong in tannin, and from the results of the small tanning experiments made it appears that the leather produced is of superior quality. It is probable that if material of the quality of this sample can be regularly produced a market for this product could be secured in this country. It is of interest in this connection to mention that small planting trials

with the tree yielding barbatimao bark are at present being made in German East Africa (p. 428), and it might be worth while to make similar experiments in some of the British African Colonies. The tree prefers a dry sandy soil, and requires fifteen years to mature before bark can be stripped from it.

COCOA FROM THE GOLD COAST.

A NUMBER of samples of cocoa beans were forwarded to the Imperial Institute for examination by the Director of the Botanical and Agricultural Department of the Gold Coast Colony in August 1905.

The collection of samples was stated to represent the products obtained in a series of experiments conducted "in the preparation of cocoa grown in the Botanical Gardens at Aburi with a view to ascertaining the most satisfactory method to adopt in preparing this product for market."

Description of Samples.

Seven samples of cocoa beans were received. These were described as follows:—

No. I	Fermented	8·5	days	Washed
No. IV*a*	"	4·5	"	"
No. IV*b*	"	4·5	"	Unwashed
No. V*a*	"	6·5	"	Washed
No. V*b*	"	6·5	"	Unwashed
No. VI*a*	"	7·5	"	Washed
No. VI*b*	"	7·5	"	Unwashed

All seven samples consist mainly of medium-sized beans, but in several a number of small and shrivelled beans are included. The colours of the beans are on the whole poor, Nos. IV*a*, IV*b* and I being the best in this respect. The husked cocoas, in all cases, show a faint purple tint and do not "break" readily, indicating that they are incompletely fermented. This is the case even with samples Nos. I and VI, which are described as

having been fermented for 8·5 and 7·5 days respectively. As regards the colour and "break" of the husked cocoas, Nos. IV*a* and IV*b* appear to be the best of the seven samples, in spite of the fact that they were fermented for the shortest period (4·5 days). Nos. I, IV*a* and IV*b* contain a few mouldy beans, and the others a larger proportion, in one case nearly ten per cent. of partially perished beans. The flavour and aroma of all the samples are mild and rather poor when compared with those of good West Indian cocoas.

Chemical Examination.

The samples were analysed in the Scientific and Technical Department of the Imperial Institute, and gave the results recorded in the following table:—

No. of sample.	Method of preparation.	Husk.	Calculated on the husked samples.			
			Moisture.	Fat.	Ash.	Total alkaloid.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
I	Fermented 8·5 days and washed . .	8·0	4·55	48·29	2·39	1·28
IV*a*	Fermented 4·5 days and washed . .	8·0	4·87	46·63	3·05	1·65
IV*b*	Fermented 4·5 days unwashed . . .	8·0	4·75	46·17	2·90	1·58
V*a*	Fermented 6·5 days and washed . .	8·0	4·89	44·51	2·74	1·20
V*b*	Fermented 6·5 days unwashed . . .	11·4	5·00	45·30	2·66	1·40
VI*a*	Fermented 7·5 days and washed . .	8·4	4·55	44·50	2·67	1·22
VI*b*	Fermented 7·5 days unwashed . . .	10·4	4·90	45·20	2·87	1·21

The results of the chemical examination show that the samples are satisfactory so far as chemical composition is concerned. It is of interest to note that the analyses indicate that samples Nos. IV*a* and IV*b* in spite of their short period of fermentation have been more thoroughly fermented than several of the others; thus the amount of husk in No. IV*b*, though unwashed, is only 8·0 per cent., identical with that found in the washed twin sample IV*a*, indicating that in these two samples practically the whole of the pulpy saccharine matter originally adherent to the shell had been utilised in maintaining the fermentation, so that none was left to be removed by the subsequent washing.

*Commercial Valuation of Samples.**

Specimens of all seven cocoas were submitted in the first instance to a firm of manufacturing confectioners, who reported on them as follows :—

"These samples are considerably better than ordinary West African cocoa ; this however is not saying much, as this is the lowest grade of cocoa excepting Hayti for which there is any considerable market.

"The writer prefers the flavour of the unwashed samples in each case. He would say that sample IV*b* is very similar to a mild Grenada, whilst samples V*b* and VI*b* have more of the Trinidad quality. Some of the samples show signs of mould, which of course detracts from their value."

This firm also offered the following general remarks with regard to the condition of the West African cocoa trade.

"The bulk of the cocoa which comes over to the European market from West Africa has received hardly any fermentation at all. The pods are simply opened and the beans dried without any attempt at proper fermentation. In our opinion no amount of grading of this kind of cocoa would materially improve the price. On the other hand, if the cocoa is properly prepared, as is done in the Portuguese island of San Thomé and in the British island of Grenada, a superior quality of cocoa would be obtained, and if fermentation is done regularly the quality will be uniform."

Samples of the cocoa were also submitted to a firm of brokers in London for valuation. They reported on them as follows :—

"*Sample No.* I.—Bold, colory reddish, even but dark 'break'; worth about 50 to 51 shillings per cwt.

"*Sample No.* IV*a*.—Pale reddish, fairly good 'break'; worth about 50 shillings per cwt.

"*Sample No.* IV*b*.—Pale reddish, apparently washed, part lean and small ; worth about 49 shillings per cwt.

"*Sample No.* V*a*.—Dull reddish, fair 'break'; worth about 49 shillings per cwt.

* Since these valuations were made prices of cocoa beans have risen very considerably, so that the figures quoted are only of value for comparison with prices obtainable for standard varieties at the same time, viz. medium Ceylon at 46*s*. to 53*s*. and St. Thomé at 50*s*. to 53*s*. per cwt.

"*Sample No.* V*b*.—Very dull, dark 'break'; worth about 47 shillings per cwt.

"*Sample No.* VI*a*.—Very dark, dull 'break'; worth about 48 shillings per cwt.

"*Sample No.* VI*b*.—Very grey and coated, but fair 'break'; worth about 48 shillings per cwt.

"During the past few months [*i. e.* late in 1905] prices of almost all descriptions of cocoa have favoured buyers, owing to large crops of Trinidad, Bahia and African sorts, and present values are moderate. Cocoa cured and prepared as samples represent would attract attention and compete with St. Thomé and West Indian kinds and would fetch good prices here."

As most of the West African cocoa which reaches this country is imported *via* Liverpool, it was considered advisable to have the samples valued also by a firm of brokers in Liverpool. This firm reported as follows:—

"Samples Nos. V*a*, V*b* and IV*b* we consider good cocoas, the value of which to-day would be 42 to 43 shillings per cwt. ex quay Liverpool, usual terms.

"The other four samples contain defective beans and are therefore not quite the same value as the first three. They would probably realise 40 to 41 shillings per cwt., usual terms. The 'usual terms' means landing expenses, and less $2\frac{1}{2}$ per cent. discount, merchants' and brokers' commission, etc., all to be paid by importer."

General Conclusions and Recommendations.

The foregoing results show that these samples of cocoa appear to be superior to the ordinary West African cocoa now imported into this country, and that if cocoa similar to the present set of samples could be regularly exported it would probably secure better prices than are now generally obtainable for the West African product.

These preliminary experiments in the improvement of cocoa may therefore be regarded as having given promising results, and it is desirable that they should be continued. Judging from the results of the present examination, it would seem that future progress may probably best be made by devoting attention to the mode in which the fermentation is carried out, since on this

the flavour, aroma and colour of the product will principally depend.

The information contained in the foregoing report was communicated to the authorities in the Gold Coast Colony, and it was suggested that small consignments of the best quality of cocoa produced by different planters should be sent to the United Kingdom for sale, in order to obtain trustworthy information regarding the value of the better grades of Gold Coast cocoa in the open market.

This suggestion was approved by the Governor of the Gold Coast, and subsequently information was received that it had been decided to ship 20 tons of cocoa, selected by the Director of Agriculture and consisting of "one ton lots," from 20 different farmers, for sale in this country. It was arranged by the Imperial Institute that these consignments of cocoa should be sold at public auction in Liverpool.

The first consignment, consisting of 114 bags ex "Nigeria," was received by the brokers on the 19th January 1907.

The brokers withdrew samples of the different lots included in this consignment and furnished the following report regarding them :—

"No. 1.—20 bags. Bright, clean, beans of fair size but not sufficiently fermented ; very saleable quality, worth 67*s*. to 68*s*. per cwt.

"No. 2.—20 bags. Bright, clean and sound beans of fair size but only partly fermented ; very saleable quality, value 68*s*. per cwt.

"No. 3.—19 bags. Bright, sound beans, on the whole fairly well fermented but containing some percentage of unfermented beans mixed with small beans ; very saleable quality, value 68*s*. to 69*s*. per cwt.

"No. 4.—15 bags. Large beans of good quality and well fermented. . The most desirable lot; very saleable, value 73*s*. to 75*s*. per cwt.

"No. 5.—13 bags. Sound beans of fair quality but mostly unfermented and mixed with small beans ; saleable, value about 66*s*. per cwt.

"No. 6.—9 bags. Bright beans of fair quality but mixed

with small and defective beans; value about 64s. per cwt.; saleable.

"No. 7.—7 bags. Beans of moderate quality and fair size; distinct traces of mouldy beans; value about 63s. per cwt.

"No. 8.—11 bags. Fair quality, mostly unfermented beans mixed with small and thin beans; value about 65s. per cwt."

The whole of this consignment was sold at an average price of 68s. per cwt.

All the parcels were saleable cocoas, but No. 4 was specially commended as representing the standard of quality which should be aimed at. Such cocoa would compete with the better kinds, such as St. Thomé, whereas if only slightly below this in quality, the price realised would be from 5s. to 7s. 6d. per cwt. lower.

The second portion of the consignment consisted of 60 bags ex "Akabo," which were received at Liverpool on 2nd February 1907. The following opinions of the different lots were supplied by the brokers previous to the sale:—

"IV.—5 bags. Good, fair beans of good size mixed with slatey beans. Value about 68s. per cwt.

"V.—7 bags. Fair quality, mixed with small and defective beans. Value about 67s. per cwt.

"VI.—12 bags. Fair quality but small and unfermented. Value about 67s. per cwt.

"VII.—13 bags. Fair quality, mixed with small and lean beans. Value about 68s. per cwt.

"VIII.—9 bags. Fair quality, mixed with small and defective beans. Value about 67s. per cwt.

"IX.—14 bags. Moderate quality, very small, badly cured, and mixed with defective beans. Value about 65s. per cwt."

The lots were sold separately and realised the following prices in bond:—

IV.—70s. per cwt.	VII.—69s. per cwt.
V.—68s. " "	VIII.—65s. " "
VI.—67s. " "	IX.—65s. " "

The brokers stated that they were rather surprised at the high price realised by one or two of the lots, which went to a Continental buyer.

Samples of the different lots were supplied to several English

manufacturers, and in certain cases criticisms and valuations were obtained, which may be quoted.

One firm stated that they could not report favourably upon the cocoa, since none of the lots would rank as average good Grenada estate cocoa. They added that lower grades of cocoa, like the present consignments, are often keenly bid for by makers of common chocolate, and realise prices which, in their opinion, are much higher than the quality justifies. They prefer not to buy such cocoas themselves, so long as good estate cocoa can be obtained at a reasonable price. In their opinion Nos. 2, 3, 4 (ex "Nigeria") and No. IV (ex "Akabo") appeared to be the best samples, at the same time they considered that better cultivation and more experience in fermenting the beans would lead to considerable improvement in the quality of the cocoa.

A second firm of manufacturers classified the cocoas, as regards commercial value, in five divisions as follows:—

A. . .	Nos. 4 and IV.
B. . .	,, 3 ,, 7.
C. . .	,, 1 ,, 2.
D. . .	,, 5, 8, V, VI, VII, VIII and IX.
E. . .	,, 6.

The Arabic numbers represent the samples ex "Nigeria," the Roman those ex "Akabo."

They stated that samples 4 and IV alone appeared to have had any effective fermentation, and that even in these samples it is not quite regular.

Conclusions.

For comparison with the prices obtained for these Gold Coast cocoas the following particulars may be quoted regarding the current rates for cocoa in Liverpool and London at the time of the sales:—

Liverpool Market, January 23, 1907.

	Per Cwt.
San Thomé	73*s.* to 74*s.*
African	62*s.* to 70*s.*

January 30.

San Thomé	69*s.* to 72*s.*
African	60*s.* to 69*s.*

February 6.

San Thomé	80*s.* to 84*s.*
African	60*s.* to 69*s.*

London Market, January 23, 1907.

		Per Cwt.
Ceylon .	Plantation: special marks .	76*s.* to 95*s.*
,, .	,, red to good. .	76*s.* to 86*s.*
,, .	Native estate, ordinary to red	65*s.* to 77*s.*
Java and Celebes	Small to good red . .	60*s.* to 95*s.*
African:—		
San Thomé, Cameroons	Grey to colory . . .	78*s.* to 85*s.*
Accra .	Fair reddish . . .	63*s.* to 75*s.*
Congo .	Red to colory . . .	70*s.* to 82*s.* 6*d.*

A comparison of the brokers' valuations of the eight lots ex "Nigeria" with the Liverpool prices of the same date shows that one sample, No. 4, was considered to be superior to the best West African cocoa then offered on the market. Three other samples, Nos. 1, 2 and 3, were valued at a little below the top market price, viz. at 66*s.* to 69*s.* per cwt., whilst the other four lots were valued at from 63*s.* to 66*s.* per cwt. at a time when 60*s.* was the lowest market quotation for West African cocoa.

Sample No. 4 of this consignment was of very good quality and was commended by the manufacturing firms consulted. There is no doubt that if cocoa of this quality can be regularly prepared in the Gold Coast it will realise very good prices in the market.

The six lots ex "Akabo" realised from 65*s.* to 70*s.* per cwt. compared with the market price of 60*s.* to 69*s.* per cwt. Only one sample, No. IV, realised 70*s.* per cwt., but three others, Nos. V, VI and VII, fetched 68*s.*, 67*s.* and 69*s.* per cwt. respectively; whilst the other two were sold at 65*s.* per cwt.

The principal defect of these Gold Coast cocoas as a whole is insufficient fermentation, which considerably reduces their

market value in comparison with other varieties. If the preparation of the cocoa could be improved in this respect, much better prices would be realised. In addition, the presence of small and mouldy beans in many of the samples also reduces their quality and value. The occurrence of a considerable proportion of small beans is no doubt due to defective methods of cultivation, whilst the development of mould in some of the cocoas may be attributed to insufficient drying after fermentation. Considerable improvement could be effected in all these directions, with the result that the quality of the cocoa would be greatly enhanced. The native farmers should be encouraged to produce cocoa similar to sample No. 4 ex "Nigeria."

"NSA-SANA" SEEDS FROM SOUTHERN NIGERIA.

THIS sample of Nsa-Sana seeds from the Calabar district of Southern Nigeria was forwarded for examination to the Imperial Institute in June 1906.

No information was received as to the botanical source of the seeds, but from inquiries subsequently made in Southern Nigeria by the Principal Forestry Officer, it appears that they are the product of *Ricinodendron africanum.*

The sample consisted of about 3½ lb. of the seeds, which were in fair condition on arrival.

The seeds were found to contain 45·2 per cent. of oil, which dried in a day on exposure to air at the atmospheric temperature, and left a wax-like residue.

The oil has been examined chemically and found to resemble t'ung oil (Chinese wood oil) in composition. The latter oil is obtained in China from two species of Aleurites—*Aleurites Fordii* and *Aleurites cordata* (compare this *Bulletin* 1907, **5.** 134). The following table gives the results obtained in the examination of the oil from the Nsa-Sana seeds and also the constants of t'ung oil for comparison :—

	Oil from Nsa-Sana seeds.	T'ung oil.
Specific gravity at 20° C.	0·9320	0·933–0·942 (at 15·5° C.)
Saponification value *	191·6	190–197
Iodine value, per cent.	147·7	149–165
Hehner value (percentage of insoluble fatty acids)	95·2	96·3
Titer test (solidifying point of fatty acids)	35·7° C.	37·1°–37·2° C.

These results, and the behaviour of the oil on drying, seem to show that the oil from Nsa-Sana seeds could be utilised as a substitute for t'ung oil; but technical trials would be necessary in order to determine this point. T'ung oil is principally sold in the United States of America, but there is also a fair market in this country, where it is used in the manufacture of linoleum and also in lacquer and varnish making. The present price of t'ung oil in London is from £32 to £33 per ton.

The Nsa-Sana oil could also be utilised for making soft-soap, and at present it would be worth from £18 to £20 per ton for this purpose. The value of the seeds would be determined by the amount of oil which they contain and the price obtainable for it.

The seeds were analysed, and the results showed that the "cake" left after the extraction of the oil would possess a feeding value approximately equal to that of decorticated cotton-seed cake.

The meal was examined for poisonous constituents, and indications of the presence of an alkaloid were observed. On this account, and also owing to the nature of the oil which the seeds contain, it seems improbable that the cake could be used as a cattle food, and very careful experiments as to its effects on animals would first have to be made before it could be recommended for this purpose. It could, however, be utilised as a manure, since it is rich in nitrogen.

* Milligrams of potash required for 1 gram of oil.

PARA RUBBER FROM MERGUI, BURMA.

THIS sample of Para rubber (*Hevea brasiliensis*) was prepared from trees in the Government plantation at Mergui, and was forwarded to the Imperial Institute for examination and valuation. The sample weighed 49 grams, and consisted of two thin sheets of pale rubber, which was clean and well prepared. The physical properties of the rubber were very satisfactory.

A chemical examination furnished the following results :—

	Per cent.
Moisture	0·5
Caoutchouc	95·2
Resin	1·6
Proteid	2·4
Ash	0·3

The rubber was valued at 5*s.* 6*d.* per lb. in London, fine hard Para from South America being quoted on the same day at 5*s.* 2*d.* per lb., and Para biscuits from Ceylon and the Federated Malay States at 5*s.* 6*d.* per lb.

This rubber is of excellent quality, and compares favourably in composition and physical properties with samples of Para rubber from Ceylon and the Federated Malay States. Consignments of similar character would find a ready sale at good prices.

CRYPTOSTEGIA GRANDIFLORA RUBBER FROM INDIA.

THREE samples of the rubber of *Cryptostegia grandiflora*, received from India, have been examined at the Imperial Institute, and the following summary of the results may be given :—

SAMPLE FROM MADRAS.

This sample consisted of three flattened cakes, weighing together about 1 lb. They were dark brown externally, but

much lighter and slightly porous within; the pores contained a small amount of uncoagulated latex and a quantity of dark-brown liquid having an acid reaction; a little vegetable impurity was also present. The rubber on arrival was soft but not sticky, very elastic, and possessed fair tenacity. After keeping for some time, however, it hardened a little and then exhibited a tendency to tear when stretched.

A chemical examination gave the following results:—

	Sample as received. *Per cent.*	Calculated for dry material. *Per cent.*
Moisture	24·7	—
Caoutchouc	67·4	89·5
Resin	5·9	7·9
Insoluble impurity	2·0	2·6

It will be seen from these figures that the rubber is of very fair quality, the dry material containing 7·9 per cent. of resin and 89·5 per cent. of caoutchouc. The amount of moisture in the sample as received was excessive, but this could be remedied by more careful preparation.

A sample of the rubber, together with a statement of the above results, was submitted for commercial valuation to brokers, who reported that it would be worth about 2*s.* 4*d.* per lb. in London (August 1903).

SAMPLE FROM JALAUN.

This sample was an irregular mass of rubber, almost black throughout, porous but quite dry, and contained fragments of bark distributed through it. The rubber was rather soft and slightly sticky; it exhibited very fair elasticity, but was somewhat deficient in tenacity. As in the case of the specimen from Madras the tenacity of the rubber diminished on keeping.

An analysis gave the following results:—

	Sample as received. *Per cent.*	Calculated for dry material. *Per cent.*
Moisture	5·5	—
Caoutchouc	79·9	84·5
Resin	8·5	9·0
Insoluble impurity	6·1	6·5

The sample from Jalaun therefore contained more resin and foreign matter than that from Madras, and its physical characters were not quite so satisfactory. The brokers to whom it was submitted valued it at 1*s.* 6*d.* per lb. compared with 2*s.* 4*d.* per lb. for the Madras specimen.

SAMPLE FROM BOMBAY.

It is stated that the climbing plant *Cryptostegia grandiflora* is very common in the Bombay Presidency, and that if the rubber is of marketable quality large supplies could be obtained.

The sample weighed about 13 ounces, and consisted of a large porous lump of rubber which had been formed apparently by the aggregation of thin sheets and scrap. It was dark coloured, slightly sticky, and contained a considerable quantity of vegetable and mineral impurities. The rubber exhibited very fair elasticity and tenacity.

The rubber was found to have the following percentage composition:—

	Per cent.
Moisture	3·6
Caoutchouc	64·3
Resin	10·1
Albuminoid matter	7·9
Insoluble matter (including ash)	14·1
Ash	8·22

The percentages of resin and albuminoid matter are both high, but the chief defect of the rubber is the presence of the large amount of insoluble matter, consisting of vegetable and mineral impurities. The presence of mineral impurity points to the contamination of the rubber, possibly the scrap rubber present in the sample, by contact with the soil, and precautions should be taken to avoid this in future. The percentage of caoutchouc is rather low, but this is chiefly due to the excessive amount of the impurities contained in the present sample.

A sample of the rubber was submitted for valuation to brokers, who reported that it was rather sticky and slightly heated, and would probably be worth 3*s.* 6*d.* per lb. in London (May 1906), when fine hard Para from South America was quoted at 5*s.* 4*d.* per lb.

JUTE SUBSTITUTES FROM THE NYASALAND PROTECTORATE.

IN a previous report on "Denje" (*Sida rhombifolia*) and "Nzonogwe" (*Triumfetta rhomboidea*) fibres from British Central Africa (this *Bulletin*, 1905, **3**. 23), it was suggested that a ton or two of each of these fibres should be sent to the Imperial Institute for examination with special reference to their behaviour in spinning and other manufacturing processes.

In accordance with this suggestion a bale of "Denje" fibre, and two bales of "Denje" and "Nzonogwe" fibres mixed, were consigned to the Crown Agents for the Colonies by the British Central Africa Government, together with a bale of "Lichopwa" fibre. Small samples were also forwarded direct to the Imperial Institute by parcel post.

"*Lichopwa*" *Fibre.*

The sample forwarded to the Imperial Institute consisted of brown ribbons of fibrous material, which contained much gummy matter. The fibre when freed from the gummy substances was soft but weak.

The following are the results of its chemical examination :—

	Per cent.
Moisture	11·8
Ash	9·8
α-Hydrolysis (loss)	43·4
β-Hydrolysis (loss)	51·0
Nitration (gain)	8·9
Cellulose	38·5
Length of ultimate fibre	3·7–15·2 mm. or 0·15–0·6 in. (mean 8·6 mm. or 0·35 in.)

The fibre was not lignified. The figures given above show that the sample contained a very large percentage of matter other than true fibre; the percentage of ash is high, and the losses on hydrolysis, which would be quite abnormal in a cleaned fibre,

can only be accounted for by the presence of a large amount of pectous or gummy matter. Commercial experts to whom this sample was submitted reported that fibre of such quality would only be saleable at a nominal price.

The material in the bale (No. 2) was in an unprepared state and was of no commercial value.

"Denje" and "Nzonogwe" Fibres.

The sample of "Denje" fibre received consisted of ribbons averaging 4 feet in length, and varying between 3 feet 3 inches and 5 feet. The ribbons were somewhat lustrous, and varied in colour from pale grey to buff. The fibre was of fair strength and fairly well cleaned.

The results of the chemical examination of this sample compare unfavourably with those obtained for the sample previously received. The figures relating to a sample of "extra fine" Indian jute examined at the Imperial Institute are added for comparison.

	Present sample.	Previous sample.	Extra fine Indian jute.
	Per cent.	*Per cent.*	*Per cent.*
Moisture	9·0	10·3	9·6
Ash	1·1	1·0	0·7
α-Hydrolysis (loss)	12·0	8·5	9·1
β-Hydrolysis (loss)	20·0	13·5	13·1
Acid purification (loss)	8·8	1·8	2·0
Cellulose	73·3	77·4	77·7

The unfavourable results are accounted for by the imperfect cleaning and preparation of the present sample as compared with the previous one. If well prepared this fibre would be of more value as a substitute for jute.

None of the samples taken from the bales was so well cleaned and prepared as this preliminary sample.

Bale No. 1, "Denje," consisted of harsh and gummy fibre varying in colour from pale buff to brown and of slight lustre. The length was 3 to 4 feet, some shorter fibre being present.

Bale No. 3 was said to be "Denje" and "Nzonogwe" fibres mixed. The fibre resembled No. 1, but was darker in colour, more gummy, and not so well prepared. The length was 3 to

4 feet, with some shorter fibre, and also a little measuring about 5 feet.

Bale No. 4 also appeared to consist of "Denje" and "Nzonogwe" fibres mixed. The fibre resembled that contained in bale No. 1, but was perhaps rather softer. The length was 3 to 4 feet, but some longer fibre was also present.

The three bales of "Denje" and "Nzonogwe" fibres were sent for trial to a firm of jute spinners in Dundee, who reported that it was impossible to differentiate between them. The fibre was insufficiently retted, and six weeks' treatment in the "batch" was necessary before spinning could be attempted.

The yarn which was obtained was a good level thread but harsh. Very little moisture was retained, although a large quantity was used in the preparatory stages. There was also an absence of the floss which is present on jute yarns. In strength the yarn was weaker than jute yarn of corresponding size. This, however, was probably due to the long time during which the fibre was soaking in the "batch."

The spinners stated that it was exceedingly difficult to give a valuation for the fibre, but they classed it as about equal to the bottom number of an ordinary Bengal jute mark. In the state in which it was received the material was valued at £16 per ton, but it would no doubt be worth much more if properly retted.

The spinners were of opinion that with more experience in retting, which is the most important process in the preparation of fibres of this class, the producers would be able to obtain a much improved fibre. They were also under the impression, though not certain on the point, that the plants had been allowed to get too old before the fibre was collected, and that consequently the gum had become very hard.

An article on "Fibres of the Jute Class," which purports to be an account of the information given in the above report, has appeared as a supplement to the *British Central Africa Gazette* of May 31, 1907. Reference is only made to this article in order to correct the following exaggerated statements. "The fibre of 'Denje' when properly prepared is superior to that of jute on all points." "When carefully prepared not only does it ['Denje' fibre] excel jute in its chemical analysis, but it is also a fibre of much finer quality, and might eventually be

used for higher class fabrics for which even the best jute is quite unsuited." "A few years' perseverance with the latter ['Denje'] . . . will in all probability be rewarded by a fibre as superior to jute from a producer's and manufacturer's point of view as it is already undoubtedly superior in chemical composition." These conclusions are not supported by the reports of the Imperial Institute, and certain figures on which the writer has based his statements are taken from another source and do not refer to the fibres of Nyasaland. Although the fibre is useful and could be employed as a substitute for jute of medium quality, there is no likelihood that cultivation of the plant, and care in preparing the fibre, would ever yield a product superior or even equal to the finest grades of jute.

A note on these fibres has been contributed by M. F. Main to the *Journal d'Agriculture Tropicale* (October 1907, 317). The writer has evidently been misled by the statements which appeared in the *British Central Africa Gazette*, and concludes by asking the following questions. Would it not be better to develop the cultivation of some of the numerous and excellent species on which a considerable amount of knowledge has already been gained rather than to investigate new species on which nothing has yet been done? Or, must it be supposed that the quality of Indian jute has deteriorated to such an extent as to justify the search for a new plant capable of replacing it?

In reply to these questions, it may be well to state that the investigation of these fibres was undertaken primarily with the object of assisting in the development of the natural resources of British Central Africa. "Denje" and "Nzonogwe" already grow abundantly in the neighbourhood of Zomba, and throughout the Shiré Highlands, and it is therefore much easier to carry on the cultivation of these plants than to introduce exotic species which would require to become acclimatised, and would in any case need intensive cultivation. As already mentioned, the fibre of these plants cannot compete with the finest qualities of Indian jute. It is a well-known fact, however, that the supply of Indian jute available for export is gradually diminishing on account of the increasing quantities which are being used in the Indian mills. During the period 1891–1906, more than £5,000,000 was expended in India on jute machinery. The

desirability of developing new sources of supply is therefore evident, and any effort made to further the production of suitable substitutes for jute is amply justified, especially when, as in the present instance, they can apparently be grown and prepared at a very small cost.

MATERIALS FOR CEMENT MANUFACTURE FROM TRINIDAD.

THESE materials, consisting of limestone and marl, were forwarded to the Imperial Institute in January 1906, with the request that their suitability or otherwise for the manufacture of cement might be determined, and that tests for tensile strength might be carried out on a sample of cement made from them.

A copy of a joint report by the Government Analyst and Government Geologist, entitled "Portland Cement as a Local Industry," was subsequently received from the Colonial Office.

This report shows that there is an increasing demand for Portland cement in Trinidad, and that this is at present met entirely by imported cement.

Since two extensive deposits of limestone of good quality occur in the island, and as supplies of marl and of dredger sludge, both of which are of a clayey character, are also obtainable, the question has been raised as to whether a fair quality of Portland cement for local use could not be made by a suitable combination of the limestone and either marl or dredger sludge. Analyses of these several materials have been made by the Government Analyst, and are given in the report referred to.

The materials sent to the Imperial Institute so that these cement trials could be made consisted of:—

(*a*) *Laventille limestone.*—This is quarried on the south side of Laventille Hill, and is also obtainable on the Five Islands and over the greater part of Gasparee and Carrera Islands, so that the supply is abundant. The sample weighed about 56 lb., and consisted of compact limestone of a light-grey colour.

(*b*) *Calcareous Naparima marl.*—This material is exposed

near San Fernando, at numerous other points on the southern coast of the island, and also inland. The supply of marl is stated to be practically inexhaustible. The sample weighed 30 lb., and consisted of yellowish-grey, somewhat pulverulent lumps which broke readily with an earthy fracture.

Analyses of both these materials were made and gave the results recorded in the following table :—

		Limestone. Per cent.	Marl. Per cent.
Lime	CaO	56·05	23·03
Magnesia	MgO	trace	—
Ferric oxide	Fe_2O_3	—	3·32
Alumina	Al_2O_3	—	13·61
Silica	SiO_2	0·79	32·46
Carbon dioxide, Water	CO_2, H_2O	43·63	28·28

These results agree fairly well with those quoted in the report already referred to.

Cement Trials.

It is now generally admitted that the essential constituents of Portland cement are tricalcium silicate, $3CaO, SiO_2$, and dicalcium aluminate, $2CaO, Al_2O_3$. Calculating from the composition of the limestone and marl as given by the analytical results, a mixture of these materials in the proportion 1·44 : 1·0 should give a cement having the composition required by the above formulæ.

The materials were ground to a powder which would pass through a sieve having 100 meshes to the linear inch, and were mixed in the proportion of 26 lb. of limestone to 18 lb. of marl, with sufficient water to form a stiff "slurry," which was made into balls. These, after drying, were gradually heated to redness in a muffle furnace. The baked masses so produced were finally placed in a plumbago crucible and heated in a blast furnace for five hours at from 1,500° to 1,600° C. The resulting "clinker," which was of a dark-green colour, was ground to a powder fine enough to pass through a sieve having 100 meshes to the linear inch. This "cement powder" was of a light-greenish colour, and had a specific gravity 3·09.

On analysis it gave the following results:—

		Per cent.
Lime	CaO	66·92
Magnesia	MgO	1·26
Alumina	Al_2O_3	6·55
Ferrous oxide, Ferric oxide	expressed as Fe_2O_3	3·28
Silica	SiO_2	21·81
Loss on ignition		0·11

Tensile Strength of the Cement.

A portion of the cement powder was mixed with 3 per cent. of its weight of "plaster of Paris" and sufficient water to furnish a paste of the proper consistence, as indicated by the Adie tester. The initial "set" took place after 1 hour. After 4 hours the material was hard enough to resist penetration by the Vicat needle. Specifications for Portland cement usually require that it should set hard in not less than 1 hour or more than 8 hours.

A test block prepared with the same paste was kept for 24 hours and then placed in water for 6 days. The block so obtained showed a clean smooth surface, which rapidly dried on exposure to air, and when subjected to tension in the Adie testing machine was found to break under a stress of 550 lb. to the square inch. The best qualities of Portland cement have a tensile strength of 600 lb. to the square inch. The fractured surface was compact and crystalline, and the material so prepared would be suitable for all purposes to which cement is applied.

General Conclusions and Recommendations.

The foregoing results show that a cement of good quality can be made from these raw materials when they are mixed in the ratio 1·44 : 1·0, and the mixture ignited to produce a "clinker" as already described.

There are, however, one or two other points to which attention should be directed before the most suitable proportions of limestone and marl are finally decided upon.

It has been found that under manufacturing conditions, when limestone and clay are employed for making cement in the proportions required by the formulæ already given, complete combination does not occur, and that free lime remains in the finished product. As the presence of free lime is detrimental to the quality of the cement, it has become customary to avoid this difficulty by using a slight excess of clay in the initial mixture.

With these Trinidad materials good results should be obtained by the use of five parts of limestone to four of marl, which would yield a cement having the following composition :—

		Per cent.
Lime	CaO	65·0
Alumina	Al_2O_3	9·5
Ferric oxide	Fe_2O_3	2·3
Silica	SiO_2	23·2

Such a cement would contain the maximum amount of lime usually permitted in specifications for Portland cement, and would at the same time give the best results obtainable with these raw materials.

If equal quantities of limestone and marl are used the cement obtained will have approximately the composition :—

		Per cent.
Lime	CaO	61·7
Alumina Ferric oxide	$\left.\begin{matrix}Al_2O_3\\Fe_2O_3\end{matrix}\right\}$	13·1
Silica	SiO_2	25·2

This cement would contain the maximum amount of silica, alumina and ferric oxide usually permitted in specifications for Portland cement.

The foregoing data will perhaps be sufficient to indicate the considerations which should govern the final decision as to the ratio in which the two raw materials should be employed, and it should also be remembered that, unless gas is employed as a fuel, the ash of the fuel will be mixed with the cement and will consequently modify its composition. In the absence of any information as to the composition of the ash of the fuel it is

proposed to employ, it was impossible to make definite suggestions as to any modifications in the proportions in which the principal ingredients should be used, in order to make allowance for the inclusion of the fuel ash.

GENERAL NOTICES RESPECTING ECONOMIC PRODUCTS AND THEIR DEVELOPMENT.

THE SPONGE INDUSTRY.

THE Imperial Institute has received recently for examination and valuation samples of sponges from Ceylon, New South Wales, West Australia, the Anglo-Egyptian Sudan and Natal, in all of which localities some attention is at present being given to the development of sponge fishing. In most cases these samples were accompanied by requests for information as to the methods of fishing sponges and preparing them for the market, and as there appears to be no recent account of this industry readily available, it has been considered desirable to publish the following account of the sponge industry, which has been prepared from various scientific memoirs, official publications and information supplied by commercial experts.

SPONGE IMPORT TRADE OF THE UNITED KINGDOM.

The average import of sponges into the United Kingdom during the last five years has been over 1,200,000 lb. per annum, valued at approximately £225,000. More than three-quarters of this import, in point of value, is derived from the Mediterranean sponge fisheries, the greater proportion, according to official returns, reaching this country from Turkey and Greece direct, with smaller quantities *via* the sponge markets of France, Belgium, Germany and the Netherlands. Not more than six per cent. of the sponge import is derived from British possessions, and practically the whole of this proportion is from the Bahamas. The United States contributes about seven and a half per cent. of the imports, entirely from the Florida fisheries.

NATURAL HISTORY AND COMMERCIAL VARIETIES.

In former years considerable difference of opinion existed as to the actual position occupied by sponges with regard to other living organisms, it even being a matter of dispute whether they belonged to the animal or vegetable kingdoms. The right of sponges to a position in the animal kingdom, however, has been now long established, and they are placed either in a separate sub-kingdom (Porifera), or classed with corals, jelly-fish, hydras, sea-feathers, etc., in the sub-kingdom Cœlenterata.

The sponge of commerce, properly speaking, is merely the home or skeleton of the sponge animal, which may be regarded as a living, fleshy mass partly filling the canals and perforations of the "sponge." Further, the whole external surface of the latter is covered with a thin, perforated, slimy, dark-coloured "skin," which is itself part of the living animal and continuous with that portion of it contained in the pores. The flesh consists largely of cells having different functions, some being concerned in nutrition and others in reproduction. Currents of water are constantly passing through the sponge body, entering by small apertures and emerging by larger, both forms of aperture being readily visible on the surface of the horny framework. The motion of the water through the animal is initiated and maintained by certain living cells of the canals which are provided with protoplasmic cilia or flagella. The object in maintaining the current is to supply the animal with food, which occurs suspended in the water, and to render efficient respiration possible. The commercially valuable portion of the animal, the skeleton, consists of interwoven horny fibres in which are imbedded siliceous spicules, which help to support the framework. The fibres themselves consist of a network of fibrils, upon the softness and elasticity of which depends the commercial value of the sponge.

Sponges multiply in nature by the union of sexual cells, fertilisation taking place in the sponge. The fertilised eggs or larvæ pass out in the efferent currents of water, and lead a short, free-swimming existence, their movements being effected by means of cilia. After one or two days the larvæ become attached to a submerged rock surface and develop into the

mature sponge; the time required depends upon the species and the locality.

Species and Commercial Varieties.

A review of the literature of the subject leads one to the conclusion that the number of species and varieties of commercial sponges recognised by zoologists is almost equalled by the numerous "grades" of the sponge merchants. The great difficulty experienced in any attempt to distinguish the species zoologically results from the extraordinary variability of the organism when grown under different physical conditions. All sponges constantly met with in commerce, however, belong to a single genus Spongia, and may be referred to four species, viz. *Spongia equina* Schmidt, *S. agaricina* Pall., *S. graminea* Hyatt, *S. officinalis* Linn. At the same time, however, recent biological investigation, especially that now being carried on in America, is rendering more and more obvious the fact that the commercial quality of sponges, to a large extent, is independent of their specific characters, and depends upon local physical conditions such as temperature of water, depth of the beds, and degree of turbidity of the water. This is strikingly illustrated in the "Glove" sponge of Florida and the "Levant Toilet" and "Turkey Cup" sponges. All these sponges are zoologically the same species (*Spongia officinalis* sub-sp. *tubilifera*), and can be recognised as such; but, whereas the Florida Glove sponge is the least valuable obtained from the American fisheries, the Mediterranean products are well known to be the finest quality of sponge fished.

The following account of the classification of sponges is given on the authority of the American zoologist Hyatt, whose monograph, *A Revision of the North American Poriferæ*, is the standard work on the classification of commercial sponges.

Spongia officinalis Linn. The true species yields the well-known Bath sponge of commerce, so largely fished in the Mediterranean. It is found on the eastern shores of the Adriatic and the coast of Greece, from Trieste to the Bay of Nauplia; thence it extends to Candia and Eritra on the coast of Asia Minor. It is also found on the sponge beds of Tripoli and Tunis. There are two important sub-species, viz. *S. officinalis*

sub-sp. *mollissima* and *S. officinalis* sub-sp. *tubulifera.* The former is the source of both the Levant Toilet and Turkey Cup sponges, constituting the finest varieties of sponge sold; while the latter is the Glove sponge of Florida and the Bahamas. As previously stated, the Glove sponge is the poorest of the American sponges, its small commercial value being due to its lack of elasticity and a tendency to become brittle with age. It has a limited distribution along the Florida coast, and is fished only to a comparatively small extent.

Spongia equina Schmidt. This species yields two important commercial sponges occurring in the Mediterranean, viz. the large Venetian Bath sponge or Horse sponge and the Gherbis sponge. It is found on the coast of Asia Minor (Eritra), Tripoli and Tunis; the Gherbis sponge being obtained at Ceuta, at the Straits of Gibraltar. The sub-species *gossypina* is the Florida Wool or Sheepswool sponge, the characteristic appearance of which is indicated in the trade name. The Sheepswool is the best sponge found on the shores of the West Atlantic, and, for general purposes, is probably equal to any other variety. It is also found abundantly on the sponge grounds of the Bahamas. The texture is coarser than that of the best Mediterranean sponges, but its durability renders it of great practical value. It is found on all the important sponging grounds off the Florida coast, the most productive regions being in the vicinity of Anclote Keys and Rock Island. The sponge is taken in water of from two to nine fathoms, but the greater quantity is fished in water of from three to six fathoms. It usually grows evenly distributed on the bare coralline rock, and is rarely found on a muddy or sandy bottom.

While the value of the Sheepswool sponge fished in Florida exceeds that of all other varieties combined, a comparison of statistics for recent years shows that the annual quantity fished is steadily diminishing. This fact is due to the partial exhaustion of the beds owing to excessive fishing, and for years past this sponge has been sought for in increasingly deeper water.

S. equina sub-sp. *meandriniformis* is the American Velvet sponge found chiefly in the neighbourhood of the Matecumbe Keys, Florida, where it is taken on a coral bottom in water of from two to three and a half fathoms; it also occurs on the

Bahamas grounds. The Velvet sponge resembles the Sheepswool in general structure, but has the characteristic appearance of soft, velvety, protruding cushions. It is a comparatively uncommon form, and the quantities obtained, which are said to be rapidly diminishing, are small.

Spongia agaricina Pall. *S. agaricina* sub-sp. *collosia* is the Florida Yellow sponge, which ranks next to the Sheepswool in quality. It is regarded by some authorities as the American equivalent of the Mediterranean Zimocca sponge. The Yellow sponge is very abundant along the Florida coast, having practically the same distribution as the Sheepswool, with which it is found growing. In recent years the supplies have somewhat fallen off, no doubt owing to excessive fishing. *S. agaricina* sub-sp. *Zimocca* yields the famous Zimocca sponge of the Mediterranean fisheries. It occurs from the Bay of Nauplia to Crete, and from Eritra to the coast of Tripoli. The American Hard Head sponges are generally regarded as being referable to *S. agaricina* sub-sp. *dura*. They are of a darker colour and harder texture than the Yellow sponge and less valuable.

The sponges known in the trade as Grass sponges are obtained from at least two American species. *Spongia graminea* Hyatt is in form a truncated cone with a coarse open structure with deep lateral furrows. *S. equina* sub-sp. *cerebriformis* resembles some forms of the Yellow sponge, but differs in having its surface marked with longitudinal ridges. It is generally cup-shaped. Grass sponges although of relatively inferior quality, are largely used for a variety of special purposes.

PRINCIPAL FISHERIES.

Bahamas.

The sponge fishery of the Bahamas is by far the most important industry of the islands, the average annual export for the last few years being valued at considerably over £100,000.

The sponges occur in the perfectly clear water of the shallows and reefs occurring in the neighbourhood of the islands, and fishing grounds, yielding sponges of fine quality, were discovered thirty years ago at Eleuthera, about sixty miles from Nassau. The sponges near Nassau lie on reefs very much exposed to

the action of the waves, often thirty miles from land and always in currents running from three to four knots per hour. It is probably owing to the continual renewal of the water by these currents, and the effect they have in concentrating the floating food material in the channels, that the excellence of the Bahamas sponges is due.

A considerable amount of capital is invested in the industry, which employs nearly 500 schooners and sloops with 2,500 boats, the crews numbering about 5,300 men and boys. Further, employment is found for a large number of men and women on shore in cleaning and packing the sponges. The vessels are usually owned by capitalists, and the proceeds of the voyage, which lasts from six to eight weeks, are divided into shares, which are apportioned among the owners, captain and crew.

The Bahamas industry at the present time stands in an assured position, the markets of the United States and Europe providing a demand, which hitherto it has been found impossible to supply fully. The satisfactory condition of the fishery is no doubt largely due to the stringent regulations which for a long time have been in force prohibiting the collection of the sponges by dredges or diving apparatus; for, although it is probable that at greater depths the yield would be richer and the sponges of finer quality, the risk of extermination involved in the wholesale collection of the sponges has rendered the framing of the regulations necessary. Nevertheless, for some time past repeated reports as to the exhaustion of the sponge beds have been received, and this fact, coupled with the increasing quantities of small immature sponges brought to market, has led to the establishment of a Sponge Fisheries Board, invested with powers for the regulation and investigation of the fisheries. A recent report by the Board shows that the fears entertained are well grounded, the most notable instance of depletion occurring in the Bight of Abaco, once the most valuable of the Bahamas sponge grounds. These beds have been depleted of all large sponges, chiefly owing to the action of itinerant (often foreign) fishermen, who have persistently pulled all the sponge that can be obtained, irrespective of size or quality. Small sponges, however, are still numerous. Accordingly, the Bight and Dead-man's Cay, Long Island, have been closed to spongers by the

Board, in order to recuperate. It is satisfactory to note that the whole work of the Board has the sympathy of the regular spongers, who realise the true position of the industry. The Board is now seeking expert advice on the numerous biological questions which have arisen during its investigations.

The clean sponges are sold in parcels by auction at the Sponge Exchange at Nassau. Some of the largest buyers deal only on commission for wholesale dealers in New York, and recently dealers from the Levant have engaged largely in the trade. Samples of Bahamas sponges are exhibited in the Bahamas Court of the Imperial Institute.

The following statistics show the extent of the Bahamas trade during the last few years. The export is chiefly to the United States, followed by that to France, the United Kingdom, Holland and Germany.

Year.	Quantity. *lb.*	Value. £
1897	1,228,000	90,000
1903	1,516,000	104,400
1904	1,308,000	105,700
1905	1,486,000	113,700
1906	1,528,802	115,528

Florida.

The sponge fishery of Florida furnishes a considerable proportion of the world's supply of sponges. The industry is the most important fishery of the State, and has its headquarters at Key West and Tarpon Springs.

The total area of the Florida sponge grounds is estimated at approximately 3,000 square miles. The grounds form three separate elongated stretches along the southern and western coasts of the State. The Florida Reef grounds, also known as the "Key" grounds, which were the earliest fished, extend for about one hundred miles from Key Biscayne in the north-west to Key West in the south, the width of the beds varying from five to thirteen miles. The two remaining grounds, known as the "Bay" grounds, and the most prolific of the Florida fisheries, are situated in the Gulf of Mexico. The first extends from just south of Anclote Keys for about sixty miles, ending immediately

to the south of Cedar Keys, with a width varying from seven to fifteen miles. The northern ground extends southwards from the mouth of the St. Mark's River for seventy miles, and is fifteen miles broad; the southern end is in close proximity to the second ground mentioned. On an average, the whole of the sponge grounds are about six miles from the shore at an average depth of from three to six fathoms.

In the last available official returns, the number of vessels and boats engaged in the fishery is estimated at approximately 400, manned by about 2,500 men. A noticeable feature with regard to the crews is the large proportion of British subjects employed, white and coloured, chiefly from the West Indian colonies. The vessels are schooners or sloops varying considerably in size, but averaging a little over eleven tons. The crews vary from four to eleven men. The capital invested in the industry amounts to over £120,000, and the fishery is worked on the share system. The owner of the boat or "outfitter" provides the vessel and all food and apparatus, and, after certain deductions, retains one-half of the proceeds of the trip, the remainder being divided among the captain and crew in varying proportions.

The cleaned and prepared sponges are purchased by buyers for wholesale firms in New York, Philadelphia and St. Louis. For many years Key West was the principal port concerned in the buying trade, but since 1891 this part of the business has rapidly expanded at Tarpon Springs. The value of the fishery for the last few years has averaged about £72,000, but experts are of the opinion that the trade is slowly diminishing. The greater part of the sponges supply the New York market, but considerable quantities are exported to Europe, the chief buying countries being the United Kingdom, Austria, France, and formerly Belgium. Canada also buys largely. The following figures give the exports since 1902:—

Year.	Quantity. *lb.*	Value. £
1902	84,127	7,855
1903	95,159	10,050
1904	64,214	7,329
1905	31,700	3,678
1906	50,953	8,783

The fishery is regulated by State legislation. Further, a biological investigation of the sponge grounds is at present being carried out under the direction of the United States Bureau of Fisheries, the question of the artificial propagation of sponges receiving special attention (see below).

Cuba.

The large and valuable sponge fishery of Cuba was commenced on a commercial scale about twenty years ago. At the present day it is of an approximate value of £200,000 per annum. The sponge beds occur on both the north and south coasts of the island, especially around the islets, the chief ports being Batabano and Caibavien. The best sponges are of excellent quality and present very little difficulty in their collection, the water being both shallow and clear.

The fishermen employed are Spaniards from the Balearic Islands, Greeks and Cubans.

The principal markets are the United States, the United Kingdom and France.

The Mediterranean and Red Sea Fisheries.

The famous Mediterranean fisheries are generally regarded as furnishing the finest sponges on the market. The superior qualities of the Bahamas sponges are probably the nearest rivals, but, as a general rule, the Mediterranean forms are of a finer, closer texture than any American " sorts," and are hence more valuable. The principal sponging grounds are those of the Greek and Turkish Archipelagos, Syria, Tripoli, Tunis, and Cyprus. The most expert divers are almost invariably Greeks, who have found their way to all the important sponge grounds of the world.

The Mediterranean is divided by hydrographers, as a result of Admiralty surveys, into two great basins, the Eastern and the Western, one of the most interesting features of distinction being a somewhat higher temperature of the water in the eastern basin. At the bathymetrical limit of abundance of good commercial sponges, viz. thirty fathoms, the temperature at the same season of the year varies from 63° to 66° F. in the western basin, as against from 66° to 68° F. in the eastern basin, excep-

tion being made for certain localities, the anomalous temperatures of which can be reasonably explained as a result of special local conditions.

The difference of temperature in the two basins is regarded by the American zoologist, Hyatt, as affording a partial explanation of the distribution of commercial sponges in the Mediterranean, especially their absence from a great part of the western basin, where they occur only on the Dalmatian shore of the Adriatic, and on the shores of Tunis, Barbary and Morocco as far as Ceuta. On the other hand, it is fully recognised that temperature is only one factor to be considered in dealing with the distribution of sponges, the physical condition of the sea bottom, especially with regard to the presence or absence of shifting mud and the deposit of suspended matter being questions of primary importance.

The Red Sea sponges, which are fished principally in the neighbourhood of Yanbo el Bahr, are generally of inferior quality. They most closely resemble the Zimocca sponge of the Mediterranean, but are red in colour, being especially dark coloured at the base; they are also somewhat brittle.

A large proportion of the sponges obtained in European and African waters are brought to the great sponge market at Trieste, whence they are distributed to all parts of the world. The average annual export of sponges from Trieste is valued at considerably over £100,000.

Tripoli.—The Tripoli fisheries, which have been worked since 1885, extend along the north African coast for a distance of about 300 miles from the Tunisian frontier on the west, to near Misurata on the east. The fishermen employed are mostly Greeks, chiefly from the islands of Hydra and Ægina, and others are from islands in the Turkish Archipelago.

The best quality sponges are obtained from the western part of the sponge beds, which are situated from ten to twenty miles from the shore, while inferior grades are taken from the eastern beds, which are not more than six miles from the land. Formerly four types of boats were employed in the fishery, the size of the boats depending upon the method of fishing adopted by the crew. The types mentioned were (1) boats carrying upwards of twenty men and using modern diving apparatus; (2) trawlers

using a sponge dredge; (3) small boats with a crew of five men, obtaining the sponges by spearing; (4) small boats carrying one or two naked divers provided with no apparatus beyond a sinking-stone. At the present time, however, the grounds are fished only by the largest "machine" boats and by the trawlers. Fishing lasts from April to October. The boats remain at sea for about two months, transferring the sponges gathered to depôt-ships attached to the fleet. At the end of the fishery the majority of the boats return home to the islands, and continue the work among the more sheltered parts of the Archipelago.

Tripoli sponges, which are of a reddish-brown colour, are regarded as inferior to those found in the Archipelago. The greater part of the catch is disposed of in the islands whence the boats come, the sponges being purchased for European merchants by Greek buyers. Small quantities are dealt with in the Tripoli market.

The Levant.—The important industry of the Levant is centred chiefly round the islands of Symi, Kalki, and Kalymno, and other islands under the jurisdiction of Rhodes. The season lasts for six months, from May to October. The fishing is generally carried out in boats manned by sixteen men, of whom five are professional divers using a modified form of diving dress. The profits are shared on a co-operative system, one-third of the catch being paid to the owner of the diving apparatus, one-tenth to the shipowners, and a varying amount to the captain, divers and crew. The Ottoman Government levies a tax upon all boats provided with diving apparatus.

The export of sponges is effected *via* Rhodes, Smyrna and Syra, the principal buying countries being Austria-Hungary, the United Kingdom, Turkey and Egypt.

Tunis.—This fishery is worked by Greeks, Arabs and Sicilians, the Greeks being the most expert fishers. The fishery is most active during December, January and February, since during the remainder of the year the sponges are said to be hidden to a large extent by masses of seaweed, which are removed by the rough weather during the months mentioned.

Cyprus.—The sponge fisheries of Cyprus, which are chiefly in the hands of Greek fishermen, are now controlled by the Board of Agriculture, under whose direction steps have been taken to

prevent reckless fishing by the use of diving apparatus. Cyprus sponges have now an established reputation in European markets. Excellent samples are exhibited in the Cyprus Court of the Imperial Institute.

Australia.

The existence of sponge beds on many parts of the Australian coast has long been known, and the possibility of working a fishery on commercial lines has received considerable attention. In 1900 an investigation at Sydney showed that no fewer than eight species and varieties of sponges likely to be of commercial value occurred on the coast of New South Wales, and that among them was a new species, viz., *Spongia* (*Euspongia*) *illawarra.* This species is said to be equal, if not superior, to any other commercial variety, and it was suggested that the sponge should be extensively propagated by artificial methods.

The Government of Western Australia has recently given renewed attention to the question of the development of the sponge industry in that State. There are about 1,000 miles of coast-line known to bear sponges of probable commercial value, and trial shipments have been sent to London for commercial valuation.

METHODS EMPLOYED IN THE FISHERY.

No fewer than four distinct methods of sponge fishing are employed in the Mediterranean. In the case of the more wealthy traders, large boats of from five to six tons burden are fitted out and manned by a crew of upwards of twelve men. Each boat is provided with modern diving dresses and apparatus of British or French manufacture, a boat carrying as many as ten professional divers. The divers leave the side of the boat in the ordinary way, and, descending to the bottom at a depth of from fifteen to thirty fathoms, gather as many sponges as possible, placing them in a net fastened to the body. It will be evident that this method allows of a very thorough gathering of the sponges available, so much so that many beds have been considerably over-fished ; further, it is stated that large numbers of sponges are inevitably destroyed by the heavily weighted boots of the divers. In order to limit the use of diving

apparatus, so far as is consistent with the successful prosecution of the industry, the Turkish Government levies a heavy tax on all boats using such apparatus on grounds within its jurisdiction. Similar action has been taken by other governments and authorities in the Mediterranean.

The second method is largely in vogue along the coast of Asia Minor, and in Tunisian, Tripoli and other waters. The apparatus employed is a form of dredge known in Tripoli as "gangara" and in Tunis "arth," which has the essential structure of the common oyster-dredge used in many parts of the world. Each dredge is worked by from four to seven men from a boat of about three tons. This method of fishing is very productive in certain favourable localities, since the dredge may be worked continuously day and night, and beds down to a depth of sixty fathoms may be fished. On the other hand, it is obvious that the persistent use of such apparatus would tend to deplete the sponge beds seriously, and, further, the passage of the heavy dredge over the sea bottom has been found to destroy large numbers of sponges by crushing, besides often tearing those actually gathered.

The third and fourth methods, originally universal on all sponge grounds, are still employed in certain parts of the Mediterranean, and form practically the only method adopted in the Florida, Bahamas and Cuban fisheries. The methods referred to are harpooning or hooking, and diving without any special apparatus. The former is carried on only in comparatively shallow water and in calm weather, the procedure being very simple. The boats are brought to the sponge grounds and the actual position of the sponges ascertained from the boats. In order to eliminate the action of the waves and ripples in preventing an examination of the sea bottom, a "water glass" is used, consisting merely of a stout metal tube (generally of tinned iron) about twenty inches long and fourteen inches in diameter, into one end of which a pane of strong window-glass has been fixed. This end is immersed in the water and a clear, undisturbed view of the sponge beds is obtained. The sponges are then speared with a harpoon provided with a varying number of prongs (according to locality) attached to a wooden shaft, and brought into the boat. In the past it frequently happened,

e.g. in Tunisian waters, that the sponges were obtained from relatively deep water by means of harpoons, the Greeks being so expert in the use of their implements that two or three spears successively were struck into the haft of that previously discharged before the first reached the sponge at which it was aimed; the combined lengths of the harpoons then enabled the sponge to be gathered.

The remaining and, popularly, the most familiar method of sponge fishing is by means of a naked diver unprovided with any special diving apparatus. Small boats, with a crew of three or four men, are employed in this method, each boat carrying a large flat stone to which a strong line is attached. The diver stands erect on the stone, and, grasping the line, is let down into the water to the sea bottom, where he gathers as many sponges as possible, placing them in a net suspended from his neck; he is then hauled to the surface. The younger men naturally form the best divers, but men of all ages are liable to paralysis of the limbs, brought about, it is stated, by the pressure of the water upon the spinal column. This method is practised in certain parts of the Mediterranean, on the east coast of Africa and also in the Caribbean Sea.

On the important Florida, Bahamas and Cuban fishing grounds the sponges are obtained by spearing. The spears are three-pronged hooks continued proximally as a somewhat heavy iron socket, into which is fixed a pole varying in length according to the depth of water to be fished. As in the Mediterranean, a "water glass" is also used, but it is generally of simpler construction, being merely an ordinary bucket, the bottom of which has been replaced by a pane of stout glass.

PREPARATION OF SPONGES FOR THE MARKET.

The methods adopted in various parts of the world in preparing the sponges for the market are the same in all essential points. The sponge as brought to the surface is a black or dark-coloured gelatinous body covered externally by the living, slimy "skin" referred to above, to which the colour is due. In the Bahamas the sponges are spread on the deck of the boat and exposed until the animals are killed. They are then transferred to special pens (known as "kraals" in Florida) built on

the shore, where, after soaking for a week or ten days, the dead sponges are beaten with flat, wooden paddles to remove the decomposing animal matter and *débris*, which is finally washed away by the tide. The pens are constructed by enclosing an area of the shore, well below the limits of high tide, by means of vertical stakes driven into the beach at intervals sufficiently short to retain the sponges within, and, at the same time, to allow of the free passage of the water in and out. The pens are also frequently built (as in Florida) in calm, shallow water, so that the sponges are always completely submerged. The partially cleaned sponges are then squeezed and worked with the hands, until all the dead slime or "gurry" runs away, when they are again washed and finally strung, three or four together, on lines or strips of palmetto leaf (*Thrinax* sp.). The sponges are then sorted and carefully clipped to a good shape, when they are put into vats of lime-water to soak for several hours. They are subsequently spread on canvas to dry and bleach in the sun, and, when this is satisfactorily accomplished, the sponges are baled by machinery and sewn up in coarse bagging for export.

In the Mediterranean a somewhat different process has at times been adopted and subsequently abandoned. In this case the bleaching has been effected by immersing the sponges in a weak solution of oxalic acid for a short time, but owing to the fact that, if left too long in the acid, the sponges become "burnt," this method has never been extensively employed. Mediterranean and other sponges are frequently worked up with dry sand, the presence of the latter being still regarded in some European markets as an indication of the "genuineness" of the article.

ARTIFICIAL PROPAGATION OF SPONGES.

On practically all the recognised sponge grounds of the world the industry is confronted with an undoubted diminution of available supplies, brought about, almost without exception, by excessive and, in some cases, reckless fishing. This state of affairs is more marked on those grounds, such as the Mediterranean, where the use of modern diving apparatus (although regulated in several instances by Government) has enabled the

sponge fishers to work more thoroughly the existing beds in relatively shallow waters, and, as supplies from these become exhausted, to seek for others in waters too deep for ordinary methods of collection.

The possibility of depleting the beds, perhaps to exhaustion, has been obvious for many years past, and from time to time efforts have been made in Europe, the Bahamas, and Florida to test the possibilities of propagating the sponges artificially. Up to the present such attempts have not met with marked commercial success, and it has been stated that it is probable that the sponge fisheries can be effectively conserved only by a strict enforcement by Government of stringent regulations as to time of fishing, apparatus employed, size of sponge fished, and, possibly, close seasons. It is obvious that such regulations, to be of value, must be based upon a complete scientific and practical knowledge of the life-history of the organism concerned.

While up to the present the attempts at artificial propagation have not been commercially successful, in reviewing the literature of the subject it is most noticeable that the failure attending such efforts has been due, almost invariably, to local conditions of such a character as to suggest that elsewhere the results of the experiments would have been different. For this reason, and on account of the marked success which has attended recent experiments in Florida, it is proposed to describe briefly the methods employed in the experiments.

Experiments in the Mediterranean.

So far as can be ascertained, the question of the artificial propagation of sponges as a commercial possibility arose from a statement in a monograph on the sponges of the Adriatic by Professor Schmidt, published in 1862, to the effect that, if a living and perfectly fresh sponge were cut into suitable pieces, which were again placed in the sea, they would grow, and in time become perfect sponges. In the following year a series of investigations was initiated by the Austrian Government, and carried out by von Buccich, to whom a large part of the modern knowledge of sponge culture is due. The experiments lasted until 1872, when the Government was compelled to abandon the

work on account of the extraordinary opposition of the local sponge fishers, who refused to refrain from fishing over the reserved area, and finally deliberately destroyed the nurseries.

Much valuable information, however, was obtained as a result of the experiments. It was found that the most suitable season for commencing propagation is in winter, and the locality chosen should be a sheltered bay with a moderate tide, clear water, and, preferably, with a rocky bottom bearing a healthy growth of algæ. Mud is the great enemy of sponge culture. The sponges chosen for cutting must be gathered with great care to avoid injury, and it was found that a drag-net was the most satisfactory form of apparatus for the purpose. The sponges, as soon as gathered, were pinned with wooden pegs to the inside of a basket, in order to avoid injury from mutual pressure and the movement of the boat. They were then cut with a sharp knife into small pieces about one cubic inch capacity, as much of the living external "skin" being left uninjured as possible. Throughout the operations it was found necessary to exercise the greatest care in avoiding injury to the sponge by pressure, and the consequent loss of the living sarcode. Subsequent operations were conducted along two distinct lines. In the first case, cuttings were attached by wooden pegs to slabs of rock which had been bored to receive the pegs, the slabs being subsequently submerged. This method possessed the advantage that the structure supporting the cuttings was quite unaffected by the Teredo worm. Further experiments, however, were carried out with a specially devised apparatus. The latter consisted of two boards about two feet long and sixteen inches broad, held parallel one above the other at a distance of sixteen inches by two short cross-bars about four inches apart. Each board was then bored at intervals of four inches, and into the holes were fixed canes sixteen inches long, which in their turn were bored through at intervals of four inches. The sponge cuttings were then threaded on to the canes and fixed in position by small wooden pegs passing through the holes. Great care was exercised in perforating the sponges, the process being effected by gently pressing the cutting against a small auger kept rapidly revolving by means of a wheel and pulley. The whole apparatus, to which were attached one hundred and forty-four cuttings, was

then weighted with stones and sunk in the sea to a depth of from sixteen to twenty-two feet. It was later proposed to substitute an iron framework for the wooden apparatus, which was affected by the sea-water and boring worms, in spite of a thick coating of tar. Apart from the opposition of the local spongers mentioned above, the chief objection, from a commercial point of view, was the length of time taken by the cuttings to reach a marketable size, the period being nearly seven years. There can be little doubt, however, that in other localities this period would have been greatly reduced, an opinion which has been confirmed by the results of recent experiments in Florida.

Experiments in America.

The principal American experiments were commenced in 1901, under the direction of the United States Commission of Fish and Fisheries, and carried out on various parts of the Florida coast. Previous attempts at propagation had been made by private individuals, and it had been found that the cuttings grew much more rapidly than in the Mediterranean, a fairly marketable sponge being obtained in little more than six months. So far as can be ascertained, the methods adopted by the Government experts have been exclusively on the plan of exposing the cutting on all sides to the sea-water, with the object of obtaining a symmetrical, more or less globular sponge, *i.e.* essentially the system finally adopted by von Buccich. The apparatus employed, however, is different from that used in the Mediterranean. Wooden stakes are driven into the sea bottom from thirty to fifty feet apart, and between them are stretched lines upon which the sponge cuttings are threaded at intervals of one foot. The cuttings measure about two inches long by one inch square, and care is taken to include as much of the uninjured outer surface of the sponge as possible. They are slit with a sharp knife for a part of their length, and then placed astride the line stretched between the supports; the free ends of the cuttings are then bound together with a rubber band exerting only moderate pressure. Formerly aluminium wire was employed for this latter purpose, but its use has now been discontinued. Within a week the opposed faces of the slit have united, and the cutting heals round the suspension line.

The results of the experiments down to the present time have shown that the Sheepswool gives the best results in artificial propagation. Further, a good marketable size of from four to four and a half inches in diameter has been reached in a period of eighteen months. That the experiments are regarded as being of practical value is evidenced by the fact that a firm engaged in the sponge trade has started propagation operations upon a commercial scale.

In conducting the experiments two special problems have been met with. In the first place, great difficulty was experienced in finding a suspension line of a material capable of withstanding the rotting action of the sea-water and the attacks of marine worms. Further, although not an absolute necessity, it has been proved very desirable that the sponge cutting should become actually fixed to the supporting line, since, if movable, the functions of the efferent and afferent canals of the sponge become interfered with to such an extent as to materially reduce the rate of growth of the sponge. Up to the present the most satisfactory combination in dealing with these difficulties is the employment of a line of ordinary marline, thoroughly tarred, and covered with lead-foil one thirty-second of an inch in thickness. The lead has been found most satisfactory in allowing the sponge to become attached to it, and the marline core, up to the present, has proved of sufficient strength to withstand the action of the waves, especially if attached to the poles by any device which will allow a certain amount of flexibility.

Raising Sponges from the Egg.

The possibility of raising sponges from the egg has also been suggested, but no definite experiments on a sufficiently large scale have been attempted.

CEARÁ RUBBER IN PORTUGUESE EAST AFRICA.

THE following report by Mr. W. H. Johnson, Director of Agriculture for the Companhia de Moçambique, on the cultivation of the Ceará rubber tree is printed by the courtesy of the Company.

HISTORY OF THE CEARÁ RUBBER TREE.

Manihot Glaziovii, Muell. Arg., the tree which produces the rubber known in commerce as Ceará, or Maniçoba, was exploited in Brazil for a considerable period before it was botanically identified.

It was discovered by Dr. Glaziow, a French botanist, in the neighbourhood of Rio de Janeiro, Brazil, and was described, and named after him, by Mueller in Martius' *Flora Brasiliensis* (XI., Part ii., p. 443) in 1874.

The plant was introduced into various Botanic Gardens as a species of the genus *Hevea*, to which the well-known Pará rubber tree belongs, with which it is still occasionally confused.

Although some seventy species of *Manihot* are said to occur in Brazil, it was generally stated until quite recently that *M. Glaziovii* alone yielded rubber of commercial value, but it now transpires that a distinct species is being cultivated in South America. The latter plant appears to be well known in Sao Paulo, South Brazil, but it has not been botanically identified, nor is it known how the rubber which it produces compares with that yielded by *M. Glaziovii*.

As early as 1876 Cross, who had been commissioned by the Indian Government to visit South America for the purpose of collecting seeds and plants of rubber-producing trees, obtained in a district about thirty miles inland from the town of Ceará some sixty plants and seven hundred seeds of *M. Glaziovii* (*Selected Papers from Kew Bulletin*, III. "Rubber," p. 118). These were dispatched to the Royal Botanic Gardens, Kew, where during the following two years they were propagated and distributed to various botanical establishments in different

countries, including India, the Straits Settlements, Ceylon, Dominica, Fiji, Jamaica, Java, Trinidad, Queensland, and Zanzibar.

To-day the Ceará tree may be found in nearly every tropical and sub-tropical country in the world.

Description of Manihot Glaziovii.

Manihot Glaziovii is a medium-sized tree, varying in height from 40 to 50 feet, with an erect trunk frequently 20 inches in diameter.

Some trees produce few erect branches, whilst others have numerous spreading branches.

The leaves are alternate, palmate, and often have petioles longer than the width of the leaf; they are thin in texture, of pale-green colour, smooth on both surfaces, and frequently coated with a white waxy floury substance. The leaves vary considerably in size even on the same tree, and also in the number of lobes, of which from three to nine may be found.

The flowers are large, the floral envelope being thick and fleshy; they are unisexual, with male and female flowers in the same semi-pendulous panicle.

The fruit is a hard, dry capsule divided into three sections, with one seed in each. They are usually larger, but otherwise similar in form to those of the castor-oil plant.

The seeds, which are ejected spontaneously and often with considerable force when the capsule dehisces, are plano-convex, about half-inch long by one-third inch wide, and have a hard, thick, shiny testa or seed coat. The latter varies in colour from light brown to dark mahogany, and is often marked with blackish blotches, which are more noticeable in the lighter-coloured seeds.

The outer bark of the trunk and old branches is thin, and scales off similarly to that of the birch, but is darker grey in colour. The bark of young trees is frequently tinged with maroon.

Both young and old Ceará trees have enlarged edible roots similar to those of *Manihot utilissima*, the Cassava or Manioca plant.

In its native habitat, which is on the verge of the great central

table-land in the north-east of Brazil, the tree appears to flourish in poor, sandy, and stony soil, and at all elevations from sea-level to 3,500 feet (*loc. cit.*, p. 130). The climate of this region is said to be dry and hot from June to December, but the statements made by different travellers respecting the annual rainfall seem to vary in a most extraordinary manner from 50 to 100 inches.

The tree is hardy, grows rapidly, and frequently commences to produce seeds when only two years of age.

In Brazil tapping is said to commence when the tree is five to six years old, at which age it has developed a trunk 8 or 9 inches in diameter (*loc. cit.*, p. 130).

The rubber obtained from the Ceará tree is exported from Brazil in three different forms. The first is extracted by peeling off the external thin layer of bark to a height of about 6 feet, and making incisions in the exposed bark with a small axe having a narrow cutting edge. The latex which exudes coagulates naturally for the most part on the trunk in the form of tears or threads, any which flows to the ground being collected on leaves, etc., placed around the base of the tree, and as soon as the rubber has solidified sufficiently it is rolled into balls. These, when packed soon after collection, agglutinate into blocks, which often weigh from 2 to 3 cwt. The rubber is of dark amber colour, and frequently emits a most nauseating smell. This form is known in commerce as "Ceará Scrap."

The second form is obtained by tapping the trunk and allowing the latex to trickle down to the ground, where it coagulates into cakes of various sizes and thicknesses, which are largely contaminated with dirt.

The third form is prepared in a similar manner to Brazilian Pará rubber, by making gashes in the bark with a small axe and collecting the latex which exudes in small cups. The rubber is prepared by dipping a paddle or similar implement in the latex, and subjecting it to the smoke given off by burning palm nuts.

Results obtained from cultivated Ceará Trees in Various Countries.

Although Ceará rubber trees have been largely planted in various parts of South America for many years, authentic

records of the amount of rubber obtained from them do not appear to be available.

Few economic plants have been so extensively distributed to different portions of the globe as *M. Glaziovii.* This is probably largely due to the fact that the germinating power of the seeds is not so fugitive as that of many other kinds, so that they travel well, and perhaps in a less degree to the hardy nature of the tree.

It does not appear, however, that any large plantation has yet given really satisfactory returns continuously, although there seems every probability that better accounts will be forthcoming from some of the Ceylon and Indian plantations at no very distant date.

The Ceará tree was introduced into Ceylon in 1877 (*Kew Report*, 1877, p. 16), and within a few years large numbers of plants had been distributed. These were propagated and planted with such energy that at the end of six years it is estimated that 1,000 acres had been devoted to Ceará rubber.

The first attempts to exploit the tree were strikingly disappointing, and it became generally stated that its cultivation was not remunerative.

The vicissitudes which the exploitation of this tree in Ceylon has undergone are well demonstrated by the fact that although 1,000 acres were planted with Ceará rubber in 1883, this area had dwindled down to 500 acres in 1903, and by the following records of the amount of rubber exported during various years:—

1892	7,280 lb.
1895	1,753 „
1896	17,591 „
1898	2,792 „

In 1905, on a Ceylon estate situated some 2,000 feet above sea-level, a planter tapped 20 trees, the age of which was not recorded, and obtained 22 lb. of dry rubber which was valued by a Colombo broker at 4·60 rupees (6*s.* 1½*d.*) per lb. (*Journal d'Agriculture Tropicale*, No. 49, 1905, p. 196). Samples of Ceylon-grown Ceará rubber were shown at the Ceylon Rubber Exhibition held in September last, and were considered by the

judges to be of better quality than any specimen of Pará rubber in the Exhibition ("Lessons of the Rubber Exhibition," *Ceylon Observer*, Sept. 28, 1906, p. 1503).

The Ceará tree was introduced into India in the same year as into Ceylon. In Mysore, South India, it flourished and reproduced itself so rapidly that it was considered a troublesome weed in some districts, and the greater part of the plants were uprooted. Later, when the price of rubber advanced, attention was devoted to the remainder (extract from *Madras Weekly Mail*, quoted in *The India Rubber Journal*, April 9, 1906, p. 406).

It was found that the trees yielded very little rubber during the first 7 years of their existence, but after 12 to 15 years *some* trees gave satisfactory returns. Recently 3 to 7 lb. of dry rubber have been collected from individual trees.

One tree 15 to 16 years of age was tapped with a view of ascertaining the total amount of rubber which it would furnish, and 7 lb. of dry rubber were obtained. It is stated that this tree suffered no ill effects from the operation, but another tree which yielded a similar amount of rubber died from the wounds inflicted during tapping (*Tropical Life*, Nov. 1906, p. 166).

Rubber from a Mysore estate was classed by London brokers as equal to the best plantation Pará produced in Ceylon and the Straits Settlements, and was valued at 6*s.* to 6*s.* 1*d.* per lb. (*India Rubber Journal*, April 9, 1906, p. 406).

On an estate at 3,000 feet elevation in South Wynaad, 400 trees gave 170 lb. of dry rubber, the work of tapping being carried out by inexperienced coolies, and it was considered that a methodical exploitation of the trees would have produced an average of 1 lb. of dry rubber per tree (*The Ceylon Rubber Exhibition—Lectures and Discussions on Rubber Cultivation and Preparation*, Ferguson, Ceylon, p. 12).

The climate of the Malay Archipelago appears to be too damp for the successful cultivation of *M. Glaziovii* (*Selected Papers from Kew Bulletin*, III. "Rubber," p. 125).

Some Ceará trees planted in 1900 in Maui, one of the Hawaiian group of islands, have grown well, and it is stated that as much as 1½ lb. of dry rubber has been obtained from a tree in one year (*Tropical Life*, Nov. 1906, p. 165).

Some experiments which were conducted under Mr. Johnson's supervision on 12-year-old Ceará trees in the Gold Coast, showed that the value of the rubber obtained did not pay for the cost of collection (*Report on Rubber in the Gold Coast and Sierra Leone*—Colonial Reports, Miscellaneous, No. 28, 1904, p. 6).

In the French Congo 2,000 adult trees tapped by 35 workers yielded 95 kilos. (209 lb.) of rubber at a cost of 5·24 francs per kilo. (2·2 lb.), and the majority of the trees died afterwards. From a similar experiment in the same region only 28 grammes of rubber per tree were obtained (*Journal d'Agriculture Tropicale*, No. 61, 1906, p. 196).

In Angola an experimenter claims to have collected 215 grammes (7·6 oz.) of dry rubber from a tree aged 7 years in six tappings; in two subsequent tappings this tree gave an additional 58 grammes, which brings the total yield up to 273 grammes (9·6 oz.) (*Journal d'Agriculture Tropicale*, No. 64, 1906, p. 317).

Two trees planted in 1898 at Conakry, French West Africa, gave 222 grammes (7·8 oz.) of rubber (dry ?) on being tapped in December 1903 (*Journal d'Agriculture Tropicale*, No. 31, 1904, p. 31).

At Zoa in the Shiré Highlands of the Nyasaland Protectorate four trees, 10 to 12 years of age, were tapped three times, and yielded an average of 155 grammes (5·5 oz.) of dry rubber per tree, but this experiment was not completed (*Journal d'Agriculture Tropicale*, No. 41, 1904, pp. 330–1).

At Lewa in German East Africa 4,000 trees, 5 years of age, were tapped three times in 1903, and gave an average of 125 grammes (4·4 oz.) of rubber per tree (*Journal d'Agriculture Tropicale*, No. 34, 1904, p. 126).

Eight-year-old trees in Quelimane, Portuguese East Africa, were tapped in 1902, and the maximum yield per tree was only 60 grammes (2·1 oz.) (*Journal d'Agriculture Tropicale*, No. 17, 1902, p. 343).

It was concluded, from an experimental tapping conducted on mature trees in Natal, that the value of the rubber obtained did not compensate for the cost of collection (*Profitable Agricultural Industries*, by J. Medley-Wood, p. 3. Reprinted from the *Natal Agricultural Journal*).

A tree 8 or 9 years of age in Inhambane, Portuguese East Africa, tapped in 1901, is reported to have given 260 grammes (9·2 oz.) of scrap rubber (*Journal d'Agriculture Tropicale*, No. 7, 1902, p. 8), while from the same district 96 trees of unrecorded age gave 284 grammes (10 oz.) of dry rubber per tree (*Journal d'Agriculture Tropicale*, No. 63, 1906, p. 263).

The foregoing records seem to indicate that, except in one or two instances, profitable results have not been obtained from the cultivation of the Ceará tree. Still it should be borne in mind that the Pará rubber tree was largely cultivated for a considerable period before a satisfactory method of tapping was discovered, and it is therefore quite possible that when the tapping of Ceará trees has been more carefully and generally studied better results will be forthcoming.

The fact should not, however, be lost sight of that experimenters, in nearly every country where this tree is cultivated, seem to be unanimous in stating that the yield of rubber from different trees of a given age, growing under identical conditions, varies in a most extraordinary manner. One tree may give returns equal to Pará trees of similar age, whereas another will furnish practically no rubber, and the produce of other trees varies between these two extremes. It is therefore clear that the tapping of the tree is not the only matter which requires investigation, and there is little doubt that more care is necessary in selecting seeds from proved varieties for cultivation.

The Ceará Rubber Tree in the Mozambique Company's Territory.

The Ceará rubber tree appears to have been first introduced into Manica and Sofala in 1895. To-day there cannot be less than 75,000 trees planted in different parts of the Territory. The largest plantations are those of (1) the Guara-Guara and Massanzane Estates Company on the banks of the Buzi river, containing some 10,000 trees varying in age from 2 to 9 years; (2) the Mozambique Company's plantation at Chibabava, which contains 7,500 trees, 1 to 5 years of age; (3) the Buzi Company's plantation of 7,000 trees, aged 5 to 9 years; and (4) various plantations in the Sena district, the majority of which are the property of the Mozambique Company, containing 30,000 trees, 3 to 6 years old.

The tree flourishes in every portion of the territory. It has been observed growing in many different soils and at elevations varying from sea-level to 5,000 feet.

Some planters complain that many of their trees have been damaged by wind, but this is not surprising considering that the wood of the Ceará tree is of brittle character, that its roots are principally produced near the surface, and that no attempt appears to have been made to plant wind-breaks in the shape of belts of trees less susceptible to be affected in this manner.

Reports with regard to the amount of rubber produced are not very encouraging, but this is doubtless due to ignorance of the best methods of extracting the rubber, and to the tapping of immature trees.

In 1903 the Chefe of the Sena district exported 22 kilos. (48·4 lb.) of Ceará rubber collected from the Mozambique Company's Ceará trees in his district, and, in 1905, 500 kilos. (1,100 lb.) of Ceará rubber were collected from trees 4 to 5 years old growing in the Gorongoza district.

No systematic experiments appear to have been conducted, previous to Mr. Johnson's arrival, to ascertain the amount of rubber that the Ceará tree is capable of producing in the Mozambique Company's territory.

At Mandigos in December 1906 Mr. Johnson obtained 180 grammes (6·3 oz.) of rubber by two tappings of four Ceará trees, 5 years of age, growing near the Commando. He is convinced that this yield would have been considerably increased had the experiment been continued, as the latex was still flowing abundantly when he left. The dry rubber was of good quality, very similar in appearance to the biscuits prepared from cultivated Pará trees.

In January 1907 Mr. Johnson tapped on three consecutive days a 5-year-old tree growing in the Chibabava plantation, and obtained 69 grammes of dry rubber. He was informed that 8·5 grammes of dry rubber had been extracted from this tree a month previous to his arrival, so that the total yield of rubber in two months was 77·5 grammes (2·7 oz.). The latex was abundant, and a much larger yield of rubber would undoubtedly have been obtained had the experiment been continued. The Chefe of Mossurize, who visited Chibabava recently, reports that the

incisions made in this tree have completely healed, and that it has not suffered from the tapping.

From a Ceará tree, 7 years old, growing on the Maruma estate, Mossurize, 80 grammes (2·8 oz.) of dry rubber were extracted in two consecutive days' tapping without diminishing the flow of latex. The rubber collected at Chibabava and Maruma was similar to that obtained at Mandigos.

Experimental Tapping of Ceará Trees at Guara-Guara.

A series of tapping experiments under Mr. Johnson's supervision was commenced on the Ceará rubber trees growing on the estate of the Guara-Guara and Massanzane Estates Company at Guara-Guara, by permission of the Directors.

It was considered that the best period to test the trees was the end of the rainy season, *i.e.* the end of April or the beginning of May, as the latex should then be active, but the experiments were unfortunately delayed until the end of May. The reason for conducting the experiments on this estate was that it contains a larger number of mature trees than any other in the Territory.

The Guara-Guara estate is probably less than 100 feet above sea-level, and is situated on the left bank of the river Buzi about 40 miles from the port of Beira (lat. 19° 50′ 10″ S.; long. 34° 50′ 30″ E. Greenwich).

The soil is a deep fertile sandy loam, and the average annual rainfall probably similar to that of Beira, which during the five years August 1901 to July 1906 was 52·311 inches.

The estate is 5,000 hectares (about 12,500 acres) in area; it was established in 1895, but was transferred in 1900 to the present owners, who unfortunately are unable to furnish any records in regard to the age of the Ceará trees.

It was estimated that the trees selected for tapping varied from 7 to 9 years of age. They are planted about 4·80 m. × 4·80 m. (15 feet 9 inches) apart, or about 175 trees to the acre.

The plantation is stated to have been much neglected, having had practically no attention beyond an annual weeding, while with a view to preventing damage by wind many of the trees have had their branches cut back to the old wood once a year.

A large number were noticed showing signs of having been maltreated in this manner on five or six different occasions.

Considering the manner in which these trees have been treated it is not surprising that they have not made very satisfactory growth. The majority of the trees commenced to branch at about six feet from the ground, some giving rise to numerous spreading branches, whereas others have more erect and fewer branches; the form of the latter trees resembles an inverted pyramid.

These two types of tree have been distinguished by some observers as "Pleureur" and "Candélabre," and described as "bad" and "good" rubber producers respectively (*Journal d'Agriculture Tropicale*, No. 41, 1904, p. 329; No. 49, 1905, p. 195). Some hundreds of trees of each type were tested at Guara-Guara, but the results obtained do not support this view.

It has also been frequently stated that the quality of the latex of different Ceará trees may be ascertained from the number of leaf lobes, but this character was found to be of no value for the purpose at Guara-Guara, as leaves with 3, 5, 7 and even 9 lobes were repeatedly noticed on the same tree.

One hundred and ten trees were selected for experiment, but before these were chosen eight trees were discarded as they were found to contain latex destitute of caoutchouc. This latex is usually pale brown, whereas the latex containing caoutchouc is milky white. It was impossible to coagulate the former by any of the methods usually adopted to bring about the coagulation of rubber latex, such as the application of heat or the addition of acids. On being left exposed to the atmosphere for several days it solidified into a brittle, resinous substance devoid of elastic properties.

The outer bark of all the eight trees which yielded no rubber was much thicker than that of the trees which produced caoutchouc-containing latex, and, although much fissured, it exhibited less tendency to scale off.

A large number of trees with thick fissured bark were examined, and it was found in practically every instance that the latex produced contained no trace of caoutchouc. It would, however, be erroneous to assume that, because a particular Ceará tree has thin scaly bark, rubber is obtainable from its

latex, as several instances have been observed by Mr. Johnson of trees which yielded latex rich in caoutchouc when they were first tapped, but afterwards produced worthless latex, and in one or two cases he has also found both good and bad latex exuding from different portions of the trunk of the same tree.

The quantity of latex produced by different trees of apparently similar age and size, growing under like conditions, and tapped in a similar manner, varies in a most extraordinary manner.

The general objects in view in conducting these experiments were, firstly, to endeavour to ascertain whether sufficient rubber could be extracted from the trees to allow of their being profitably cultivated in this Territory, and, secondly, to determine the method of tapping which would furnish the maximum yield of rubber while at the same time causing the minimum amount of damage to the tree.

Some of the largest and best-formed trees were chosen for experiment, and as it is estimated that their ages varied from 7 to 9 years, it would, in Mr. Johnson's opinion, be perfectly reasonable for the purpose of this report to put the average age of the trees at 8 years. The average circumference of the trees taken at a metre (39·37 inches) from the ground was 75·24 cm. (29·62 inches), the largest circumference at this height being 1·13 m. (44·49 inches), and the smallest 60 cm. (23·62 inches).

The 110 selected trees were divided into 19 groups, each consisting of 5 trees with the exception of group No. XIII, which contained 20 trees.

The trees in each group were treated in a different manner, variations being made either in the mode of tapping or in the time which was allowed to elapse between successive tappings.

Fifteen of the tapping implements, which have proved most successful for tapping rubber-producing trees in different parts of the world, were tested with a view of ascertaining the type of instrument best adapted for exploiting the Ceará tree. The following is a list of the implements used :—

(1) Christophe tapping-knife ; (2) Michie-Golledge tapping-tool (small and large sizes) ; (3) Macadam comb-pricker ; (4) Bowman-Northway puncturing-tool ; (5) Macadam-Miller tapping-knife ; (6) Macadam paring-chisel ; (7) Holloway's tapping-knife ; (8) Pull and Push tapping-knife ; (9) Viper

tapping-knife (short and long patterns); (10) Bowman-Northway plane No. 1; (11) Bowman-Northway parer No. 2; (12) Tree pruning-knife; and (13) the Patent V.D.K. tapping-instrument.

It was not found practicable to tap the trees successfully with any one of these implements until the outer bark had been removed. It was also found that unless this course were adopted, a large amount of the latex which exuded from the incisions flowed down between the two layers of bark, and was difficult to collect. Fortunately the outer bark consists of dead tissues, and can be easily removed by making a longitudinal incision through it on one side of the trunk, reaching as high as it is desired to operate, and then peeling it off in transverse strips.

Although the outer bark is rarely thicker than $\frac{1}{50}$th of an inch, it is so hard and coriaceous that it rapidly turns the edge of the tapping implements employed. In one or two cases where the first incisions were made after a good deal of labour without its removal, the portion nearest the incision commenced to peel off of its own accord after a few days.

The living bark immediately below the outside coriaceous layer is of bright green colour striped with white, but it was occasionally observed that certain trees had large pale yellow unhealthy-looking blotches. Whether this latter character is due to disease cannot yet be definitely stated, but in nearly every instance it was found that these areas furnished far less latex than the green-coloured portions.

The experiments showed that the flow of latex was far greater before sunrise and after sunset than during the day, and on cloudy days than when the sun was shining brightly. The yield of latex was also much greater from trees tapped in the early morning than from those tapped by a similar method in the evening. This fact will be seen by comparing the figures in Table I on pages 418, 419, showing the amount of latex yielded by the trees in Groups II*a* and I*b*, which were tapped in the morning, and that from Groups VII and VIII respectively, which were tapped in the evening with the view of demonstrating this point. This phenomenon is probably accounted for by the pressure of the sap in the plant vessels being greater in the morning, as less water vapour is transpired by the plant during the night,

when the temperature is usually much lower than during the day.

In tapping the Pará rubber tree, it is almost invariably found that the maximum yield of latex is not obtained from the first incisions. Frequently the greatest flow of latex does not occur until after the twelfth tapping, but usually it takes place after the seventh or eighth tapping.

It is generally considered that this characteristic behaviour, which is commonly known as "wound response," is due to a flow of latex towards the injured part for the purpose of repairing the damage inflicted by the tapping.

The Ceará trees at Guara-Guara were not found to behave in this manner, as out of thirteen groups of trees, six yielded the greatest amount of latex from the first tapping, three from the second, and four from the third. In four of the groups the trees were first tapped on one side and then on the other side of the trunk, and all, with a single exception, yielded the greatest amount of latex from the first incisions.

The effect of tapping on the Ceará trees at Guara-Guara was therefore contrary to that observed in the case of Pará trees. The initial tapping seemed to drain the latex from a fairly large area near the incision, and when repeated by excising a thin shaving from the lower side of the wound scarcely a trace of latex exuded. All the vessels near the edge of the wound appeared to be completely denuded of moisture of any description, and a much thicker shaving of bark had to be removed than is necessary in re-tapping Pará trees. Further, this dried-up tissue is exceedingly difficult to tap, being far more brittle than the bark which has its cells distended with moisture.

The bark of the Ceará tree is much thinner than that of the Pará tree even if measured before the leathery rind is removed. The tappable portion of the bark of the former, after removal of the external layer, was observed to vary in thickness from $\frac{1}{16}$th to $\frac{3}{16}$ths of an inch (1·5 to 4·5 mm.), but the average thickness was a mean between the two, viz. $\frac{1}{8}$th of an inch (3 mm.). The bark of the Pará tree usually varies in thickness from $\frac{1}{8}$th to $\frac{1}{2}$ inch (3 to 12·5 mm.).

Much greater care has therefore to be exercised in the tapping of the Ceará tree in order to avoid damaging the cambium tissue,

which is situated between the bark and the wood and from which new tissues are formed.

The experiments at Guara-Guara seem to indicate that it will not be possible to tap the Ceará tree as extensively as the Pará tree.

Frequent instances were noticed by Mr. Johnson in which the layer of cambium tissue exposed by the tappers had commenced to dry and peel off, leaving the wood bare. Such wounds will require months, and in exceptional cases perhaps years, before they thoroughly heal. It is, however, only fair to point out that the operations at Guara-Guara were commenced with unskilled kaffirs, who had never seen a rubber tree tapped in a proper manner, the only method known to them being that usually employed in extracting rubber from the indigenous *Landolphia*, which consists in slashing off huge slices of bark and wood with crude bush-knives. Their work was, however, vigilantly supervised, and careless tapping was by this means prevented as much as possible.

The bark of several trees, which in Mr. Johnson's opinion had not been too severely tapped judging by the methods employed in exploiting other rubber-producing trees, commenced to decay, and on closer examination it was found that the cambium tissue seemed to be in an unhealthy condition. This, however, was not observable until the trees had been tapped several times. In nearly every case the decay appeared to be coincident with the unhealthy-looking blotches in the bark, the existence of which has been previously referred to. If the assumption that the appearance of this tissue is due to disease be correct, it follows that the decay may not be altogether due to excessive excision of the bark.

As will be explained later the bark was not excised from the trees in Groups XI and XII, but rings of pricks 33 cm. (13 inches) apart, one below the other, were made in the bark on alternate days, and the rubber collected in the form of "scrap." After the eleventh pricking very little latex exuded, and as the bark of several trees commenced to develop a brown unhealthy appearance in and around the pricked areas the work was abandoned.

In each experiment the tapping was immediately abandoned

when a tree exhibited signs of exhaustion or upon the slightest indication of decay.

In the tapping of Pará trees it is found that by alternately shaving and pricking the lower surface of the wound a far greater yield of latex is obtained for the amount of bark excised than if the pricking method were not adopted. In the case of the Ceará trees at Guara-Guara, however, it was found that the surfaces of the wounds dried up too much for an appreciable yield of latex to be obtained by pricking them.

The latex of the Ceará tree is thicker than that of the Pará tree, and very rarely requires any treatment to induce coagulation, in fact great difficulty was experienced in preventing the separation of the rubber from the latex before collection. Even when a strong solution of ammonia was added coagulation was not appreciably checked.

The latex from the spiral and herring-bone incisions was collected by placing cups on the ground at the base of each incision. It was found that the flow of latex into the collecting cups is considerably facilitated if a small trough cut out of the leathery outer rind, which is peeled off the tree previous to tapping, is inserted at the base of each incision.

Both enamelled iron and lead-covered collecting cups were employed, but as the former have a smoother surface, less difficulty was experienced in collecting the latex from them.

With a view to retarding the coagulation of the latex in the collecting cups, solutions of formaldehyde, varying in strength from 1 to 5 per cent., were placed in the cups, but, although coagulation was delayed to a certain extent by this treatment, it was not completely checked previous to the collection of the latex in any one instance. In fact a strong solution of formaldehyde, which was erroneously placed in one set of collecting cups, caused almost immediate coagulation.

The latex collected on certain days was treated with a 1 per cent. solution of creosote with the view of antisepticising the rubber, and this addition caused almost immediate coagulation.

Certain samples of the rubber were submitted to the smoke and heat given off by wood fires, in order to enable a comparison to be made between rubber thus cured and that obtained by other processes.

A full account of the various methods employed (1) to retard the coagulation of the latex in the collecting cups, (2) to hasten the coagulation of the latex after collection, and (3) to cure the rubber, will be given in a succeeding report after the various samples have been examined at the Imperial Institute.

A detailed description of the various methods of tapping employed and the yield of rubber obtained therefrom is given in Table I on pages 418, 419.

Except where otherwise stated the outer rind was peeled off the trunk up to a height of 2 metres (6 feet 6 inches) from the ground before tapping.

Percentage of Rubber in the Latex.

The percentage of rubber in the latex varied in a most extraordinary manner from day to day and from different groups of trees, but on comparing the yield of rubber obtained from the total amount of latex collected from each group of trees the variation is not so striking. As shown in Table II on page 420, the highest percentage of rubber in the latex (24 per cent.) was given by the trees in Group I*b*, whilst the lowest (16·4 per cent.) was furnished by the trees in Group II*a*. The percentage of rubber produced from the total amount of latex collected was 19·07 per cent.

Yield of Rubber compared with the Amount of Bark excised.

It has been previously mentioned in this report that the best method of tapping is that which extracts the greatest amount of latex and causes the least damage to the tree.

Except in the case of the trees in Groups XI and XII, the general principle of the tapping methods employed at Guara-Guara was first to excise, from different parts of the two metres of trunk nearest the ground, strips of bark about ¼ inch wide, and varying in depth in proportion to the thickness of the bark of the tree operated upon, so as not to injure the cambium layer.

The subsequent operations consisted in shaving off thin layers of bark from the lower side of the initial incisions, excepting, of course, the perpendicular channels made to convey the latex from the transverse incisions in the so-called "herring-bone" method of tapping.

As uniform care was taken to prevent damage to the cambium tissue throughout each series of experiments, it may be reasonably assumed that the most destructive method of tapping was that which necessitated the excision of the largest area of bark, and the best method that which furnished the greatest amount of rubber proportionate to the area of bark excised.

Table II on page 420 gives the average area of bark excised per tree, the yield of rubber per tree, and the average yield of rubber per 100 sq. cm. of bark excised from the trees in each group.

On consulting this table it will be found that the best results were obtained from Group III*a*, which yielded 27·77 grammes of rubber for every 100 sq. cm. of bark removed, and the worst from Group IV*b*, which only yielded 4·26 grammes of rubber by the removal of the same amount of bark.

It is, however, too early to state definitely which method of tapping will eventually produce the most successful results, but it is proposed to obtain a satisfactory solution to this problem before the second part of this report is issued.

Tapping Implements.

Of the various implements tested for making the "spiral" and "herring-bone" incisions, the "Christophe" tapping-knife, with guide removed, proved most satisfactory for making the initial cuts. The guide supplied with this knife is supposed to regulate the depth of the incision, and thus to prevent damage to the cambium, but, as it only seemed to confuse the tappers, it was discarded. For subsequent shaving operations, the "Michie-Golledge" rubber-collecting tool, small size, was found to be the most suitable.

Both of these instruments are easily manipulated. Every part of the former is made of metal, and it is provided with three interchangeable blades, which are held in position by screws. The only part of the knife likely to be easily put out of working order is the cutting edge, which requires constant sharpening if careful tapping is to be carried out. The shaving instrument is in the form of a bevelled chisel, and is admirably adapted for shaving off fine layers of bark from the side of the wound, but like the former it requires constant sharpening.

TABLE I.

Experiment.	Method.	Average yield of latex per tree.		Average yield of "biscuit" rubber per tree.		Average yield of "scrap" rubber per tree.		Total average yield of dry rubber per tree.	
		c.c.	*fl. ounces.*	*grammes.*	*ounces.*	*grammes.*	*ounces.*	*grammes.*	*ounces.*
I*a*.	Five trees: ten tappings each. Full spiral system, incisions 30 cm (11·8 inches) apart; lower surface of wounds shaved every alternate day, with interval of eight days between the fifth and sixth tappings	304	10·72	53·3	1·88	36·5	1·29	89·8	3·17
I*b*.	Five trees: six tappings each. Method similar to I*a*, except that the wounds were shaved every fourth day	284	10·0	68·1	2·40	42·8	1·51	110·9	3·91
II*a*.	Five trees: ten tappings each. Method similar to I*a*, but only 25 cm. (9·8 inches) between the incisions	435	15·34	71·3	2·51	74·7	2·63	146·0	5·14
II*b*.	Five trees: seven tappings each. Method similar to II*a*, but wounds shaved every fourth day	286	10·09	59·1	2·08	51·2	1·81	110·3	3·89
III*a*.	Five trees: ten tappings each. "Herring-bone" incisions on one side of trunk, 33 cm. (13 inches) between each transverse incision; wounds shaved every second day, but interval of eight days between the fifth and sixth tappings	556	19·61	108·4	3·82	65·9	2·32	174·3	6·14
III*b*.	Five trees: seven tappings each. "Herring-bone" incisions on each side of tree, transverse incisions 33 cm. apart; wounds shaved every fourth day	306	10·79	66·9	2·36	66·1	2·33	133·0	4·69
IV*a*.	Five trees: thirteen tappings each. One side of tree tapped with "herring-bone" incisions 23 cm. (9 inches) apart; wounds shaved every second day; after fifth tapping the opposite side of the tree was similarly treated, leaving the side first tapped to rest	385	13·58	83·6	2·95	58·5	2·06	142·1	5·01
IV*b*.	Five trees: seven tappings each. "Herring-bone" incisions 23 cm. apart on both sides of trunk; wounds shaved every fourth day	181	6·39	36·0	1·27	24·7	0·87	60·7	2·14
V*a*.	Five trees: nine tappings each. "Herring-bone" incisions 33 cm. (13 inches) apart on both sides of trunk; wounds shaved every second day	242	8·55	52·3	1·85	47·2	1·66	99·5	3·51
V*b*.	Five trees: six tappings each. Method similar to V*a*, except that wounds were shaved every fourth day	254	8·96	46·1	1·62	25·1	0·89	71·2	2·51
VI*a*.	Five trees: nine tappings each. Method similar to V*a*, except that transverse incisions were 23 cm. (9 inches) apart, and that trees were rested for eight days between the fifth and sixth tappings	242	8·55	39·9	1·41	37·7	1·33	77·6	2·74

VI*b*.	Five trees: six tappings each. Method similar to VI*a*, except that wounds were shaved every fourth day	210	7·41	34·9	1·23	39·5	1·39	74·4	2·62
VII.	Five trees: six tappings each. Method similar to II*a*, but tapped during evening to compare flow of latex with that during morning	131	4·62	23·2	0·82	47·7	1·68	70·9	2·50
VIII.	Five trees: six tappings each. Method similar to I*b*, but tapped during evening to compare flow of latex with that during morning	315	11·11	56·2	1·98	109·7 *	3·87 *	165·9	5·85
IX.	Five trees: eleven incisions each. Rind taken off one side of trunk and "herring-bone" incisions made 33 cm. (13 inches) apart; wounds shaved every second day. After the fifth tapping the opposite side of the trunk was treated similarly, and the side first tapped allowed to rest	337	11·89	56·1	1·98	74·9	2·64	131·0	4·62
X.	Five trees: eleven tappings each. Method similar to IX, but incisions only 23 cm. (9 inches) apart	332	11·71	59·5	2·10	56·9	2·01	116·4	4·11
XI.	Five trees: eleven tappings each. Rind taken off one side of trunk and six half rings made with "Macadam's Comb-Pricker" about 33 cm. (13 inches) apart; on every second day similar incisions were made immediately below the previous ones. After the fifth tapping the opposite side of the trunk was similarly treated and the side first tapped rested †	—	—	—	—	—	—	147·7	5·21
XII.	Five trees: eleven tappings each. Rind taken off trunk up to 2 metres (6·61 feet); six rings of pricks made with "Bowman-Northway Pricker" about 33 cm. (13 inches) apart; on every second day similar incisions were made immediately below the previous ones †	—	—	—	—	—	—	138·5	4·88
XIII.	Twenty trees: twelve tappings each. Rind taken off one side of tree; single perpendicular channel made from base to a height of 2 metres in the extreme left edge of the exposed bark; transverse incisions 33 cm. apart, each extending about one-third round trunk made in exposed bark leading into the perpendicular channel; lower side of transverse cuts shaved every second day. After fifth tapping the first tapped area was rested and rind taken off opposite side of trunk; similar incisions alternating with first series were made, leading into perpendicular channel; wounds shaved every second day. About one-third of trunk left untapped	271	9·56	51·9	1·83	26·0	0·92	77·9	2·75

* One tree is estimated to have furnished quite half the total amount of "scrap" rubber collected from these five trees.
† The whole of the rubber obtained in these two experiments (XI and XII) was collected in the form of "scrap."

TABLE II.

Experiment.	Quantity of latex obtained from five trees.	Quantity of dry rubber from latex.	Percentage of dry rubber to latex.	Total average yield of dry rubber per tree.	Average amount of bark excised per tree.	Average yield of dry rubber per 100 sq. cm. of bark excised.
	c.c.	*grammes*		*grammes.*	*sq. cm.*	*grammes.*
I*a*.	1520	266·5	17·5	89·8	1676·4	5·36
I*b*.	1418	340·5	24·0	110·9	984·9	11·26
II*a*.	2175	356·5	16·4	146·0	1594·4	9·16
II*b*.	1430	295·5	20·7	110·3	1234·3	8·94
III*a*.	2780	542·0	19·4	174·3	627·6	27·77
III*b*.	1530	334·5	21·9	133·0	1537·7	8·66
IV*a*.	1926	418·0	21·7	142·1	1447·4	9·82
IV*b*.	905	180·0	19·9	60·7	1424·8	4·26
V*a*.	1210	261·5	21·6	99·5	1444·2	6·89
V*b*.	1270	230·5	18·1	71·2	1153·3	6·17
VI*a*.	1212	199·5	16·5	77·6	1564·7	4·96
VI*b*.	1051	174·5	16·6	74·4	972·7	8·06
VII.	655	116·0	17·7	70·9	956·6	7·41
VIII.	1575	281·0	17·8	165·9	984·9	16·84
IX.	1685	280·5	16·7	131·0	1765·1	7·42
X.	1660	297·5	17·9	116·4	1912·4	6·09
XIII.	5420 *	1038·5	19·2	77·9	855·9	9·11
Average figures from the results for 100 trees.	—	—	19·07	108·94	—	9·3

* Latex from twenty trees.

Yield of Scrap Rubber.

A striking feature of these experiments is the abnormally large percentage of "scrap" rubber collected.

The comparative yields of scrap and biscuit rubber from each group of trees are given in Table I on pages 418, 419, and show that Groups VII and VIII produced nearly twice as much scrap as biscuit rubber, whilst three other groups yielded more scrap than biscuit rubber. The large yield of scrap rubber from Groups VII and VIII is, however, partly accounted for by the fact that the trees were tapped in the evening when the latex is considered to be thicker and therefore more liable to form scrap rubber, as it flows less freely and consequently coagulates more readily.

The production of scrap rubber could doubtless be considerably diminished by the employment of "drip tins," or a similar arrangement, which would provide a slow continuous flow of water along the excised surface of the wounds to flush the exuding latex down into the collecting cups. It is also probable that the adoption of such a system would materially increase the yield of rubber, for it was frequently observed that the latex on issuing from the excised surface coagulated and closed up the wounds, thus checking any further flow.

The bark shavings also contained a small quantity of scrap rubber, and it was found that its collection was considerably facilitated by soaking the shavings in water for a few hours.

Anticipated Yield and Profits.

Although it is considered inadvisable to enter into details in this part of the report respecting the profits likely to accrue to the cultivator of the Ceará rubber tree in the Mozambique Company's territory, a brief summary of the results already obtained will probably be acceptable.

In any case it will be readily understood that it would be impracticable to base the cost of collection and preparation on a series of small experiments. The ultimate results can only be satisfactorily stated when the effect of the different methods of tapping on the trees has been ascertained, and the number and extent of the tappings possible in a year have been determined.

The total average yield of dry rubber per tree at present stands at 112·5 grammes (3·97 oz.), made up of "biscuit" and "scrap" in almost equal quantities.

As about 175 trees have been planted per acre, the total yield of dry biscuit and scrap rubber per acre is approximately 19·69 kilos. (43·42 lb.).

The general character of the rubber collected at Guara-Guara is very similar to Ceylon plantation Ceará, the London market prices for which in June last were about 4*s.* 11½*d.* to 5*s.* 7½*d.* and 3*s.* 10¾*d.* to 4*s.* 2*d.* per lb. for biscuit and scrap respectively. Taking a mean of these figures, the value of the rubber yielded per acre up to date at Guara-Guara is £10 2*s.* 7*d.*

If due consideration be given to the unfavourable conditions under which these trees have grown, and as it is anticipated that they may be tapped at least twice and possibly three times a year, the prospects of profitably cultivating the Ceará rubber tree in this territory are distinctly encouraging.

RECENT DEVELOPMENTS IN GERMAN EAST AFRICA.

CULTIVATION OF SISAL HEMP.

In a previous number of this *Bulletin* (1907, **5**. 28) reference was made to the cultivation of sisal hemp in East Africa, and an indication was given of the remarkable progress which the industry has made on German territory. The appearance in *Der Pflanzer* (1907, **3**. 229) of a full account by Dr. F. Stuhlmann, of the cultivation and exploitation of this fibre in German East Africa, has now rendered it possible for further particulars to be given.

In 1893 the German East Africa Company in East Usambara ordered 1,000 sisal plants from Florida, but only 62 survived the journey. These were carefully tended in the plantation at Kikogwe and new plants were propagated from them, so that in 1898 the number had increased to 63,000. In 1899 machinery was introduced for extracting the fibre. By the beginning of

January 1900 there were no less than 150,000 plants established, of which 4,000 were more than three years old and were ready for cutting. After it had been ascertained by means of small samples sent for valuation that the fibre was of good quality, the first consignment was made in 1900. The following are the amounts and values of the exports of sisal hemp from Kikogwe during the years 1900 to 1906 :—

Year.	Amount.	Value.	Year.	Amount.	Value.
	Tons.	£		*Tons.*	£
1900	7½	155	1904	624	18,300
1901	45	1,300	1905	887	27,000
1902	177	5,445	1906	986	32,000
1903	347	9,860			

In 1904, out of a total of 1,800,000 plants, as many as 1,300,000 were ripe for cutting, and from these were obtained 624 tons of fibre, whence the yield per plant was about 17 oz. The same number of plants were cut in 1905, and yielded 887 tons or about 25 oz. per plant. In 1906 there were 1,600,000 plants fit to be cut, and these produced 986 tons of fibre or about 22 oz. per plant. From these figures it appears probable that each plant, after reaching the age at which leaves can be cut from it, will give an annual yield of 17–23 oz. of fibre, and that in a carefully cultivated plantation about two-thirds of the total number of plants will be ready for cutting if replanting is carried out where necessary. From a million plants, of which 666,000 can be cut annually, a crop of 333–433 tons of fibre may be anticipated. In order, however, that this yield may be maintained it is necessary that half-a-million new plants should be inserted between the old ones, as cutting can only be carried on for two or three years in German East Africa before the plant puts forth its inflorescence or "pole." It is calculated that if 800 plants are planted per acre an annual crop of 900–1,200 lb. per acre should be obtained. The results obtained at Kikogwe lend support to this estimate.

The following table gives interesting particulars as to the approximate number of agave plants in the different districts of German East Africa at the beginning of 1907, and the proportion which were ready for cutting :—

District.	Number of plantations.	Number of plants.	Number of plants ready for cutting.	Total area planted.	Area occupied by plants ready for cutting.
				Acres.	*Acres.*
Tanga	13	10,305,600	2,168,000	14,250	3,190
Wilhelmstal . . .	3	810,160	—	560	—
Pangani	2	3,330,000	2,200,000	5,000	3,500
Lindi	5	1,127,000	110,000	1,330	137
Total	23	15,572,760	4,478,000	21,140	6,827

In the Tanga district the low proportion of the plants which were ready for cutting is explained by the fact that at the time of making the estimate many of the recent plantings had not yet reached maturity.

The four districts mentioned above require a total number of daily workers of 8,500, or, allowing for absence from illness or other cause, a staff of at least 11,300 people. The workers are paid on the average 40 hellers per day.

The machine employed for sisal hemp extraction in the larger undertakings in German East Africa is one which is used to some extent in Yucatan, Mexico, and is known as the "Mola" machine. It costs about £650, is capable of treating from 85,000 to 120,000 leaves in ten hours, and needs about 48 H.P. to drive it. The bundles of leaves as brought in from the plantation are placed by one or two workers on a travelling lattice, which carries them up to a table in front of the machine. Four men are then required to open the bundles and lay the leaves on the conveyor, which introduces them to two raspadors arranged at right angles to one another, where they are cleaned, one-half of the leaf being stripped at a time. The fibre on leaving the machine slides down on a wooden frame, and is then subjected to washing, women being employed for this work. In order to keep the machine sufficiently employed a plantation of at least 600,000 plants is requisite, which, allowing a space of 4 × 10 inches for each plant, will cover an area of about 310 acres. Disadvantages possessed by this machine are the difficulty of replacing damaged parts, and the lack of durability of the bronze coating with which certain portions of the machine are provided.

The following are the approximate quantities and value of the sisal hemp exported from German East Africa since 1902:—

Year.	Quantity. *Tons.*	Value. £
1903 . . .	422	16,000
1904 . . .	765	28,300
1905 . . .	1,140	43,900
1906 . . .	1,836	66,900

During the first half of 1907 the exports from Tanga and Pangani amounted to about 1,321 tons of value £50,600.

COTTON CULTIVATION.

In a previous number of this *Bulletin* (1904, **2**. 256) reference was made to experiments in cotton growing which had been carried out in German East Africa during 1903. Since this time the industry has made rapid strides, and an account of its progress has appeared recently in *Der Pflanzer* (1907, **3**. 195–229).

In 1904 an area of 5,000 acres was planted, 26 gins and 13 baling presses were introduced and a steam ginnery was established. The Colonial Economic Committee started a cotton-farm on the Lower Rufiji, principally for affording instruction to the natives. Since it had been found that Egyptian varieties gave the best results in German East Africa, Professor Zimmermann of the Biological Agricultural Institute at Amani and Inspector Becker paid a visit to Egypt to study the methods of cultivation. The cultivation in German East Africa is now almost entirely restricted to Egyptian cotton, the "Abassi" variety especially being planted.

In 1905 the area devoted to cotton was increased, new ginning stations were established, and planting was extended on the Victoria Nyanza near Nera in the Mwanza district and also at Kilimanjaro. All the saw-gins then in use were replaced by roller-gins, the latter being much better adapted to the treatment of Egyptian cotton.

In the spring of 1906 six steam ginneries were in operation. During the same year the Committee came to the conclusion that cultivation on a large scale by modern methods was preferable to small undertakings, and they therefore established large farms provided with steam ploughs in the Kilwa district

and at Saadani and Mwanza, and extended the plantations at Pangaja and Rufiji.

The exports of cotton from German East Africa during the years 1900–1906 were as follows :—

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	lb.	£ s.		*lb.*	£
1900	24	0 5	1904	414,850	6,250
1901	240	4 14	1905	416,270	9,930
1902	818	10 12	1906	415,930	9,050
1903	20,450	370 0			

A much larger quantity has been exported during 1907, as the industry has undergone great extension. Specimens of the cotton from Kilwa, Saadani and Mwanza were valued at the beginning of 1907 at about 11*d.* per lb.

EAST AFRICAN COPAL.

This valuable varnish resin is obtained in the coast-lands of the East African Protectorates and comes into commerce under the name of "Zanzibar" or "Indian" copal, depending upon whether it is shipped to Europe from Zanzibar or *via* Indian ports. Two varieties occur in commerce, viz. "fossil" and "recent" resin, the former being found buried in the earth on the sites of old forests of copal trees and the latter being obtained by tapping existing copal trees (*Trachylobium verracosum* or *T. mossambicense*). According to an article contributed by Dr. Foelsing to the *Tropenpflanzer* (1907, **11.** 478), a method has been devised of extracting a substitute for copal from the fruits of the copal tree, which contain 8 per cent. of resin in the kernel and 15 per cent. in the soft shell. It is mentioned that the fruits are obtainable in large quantity. No details of the process of extracting the resin are available, but it is stated that the method has been patented in the principal civilised States, and that the product obtained has all the properties of purified and *melted* Zanzibar copal, and unlike the copal of commerce is directly soluble in organic solvents without preliminary melting. In a note appended to Dr. Foelsing's article the editors of the *Tropenpflanzer* point out that copal

trees are now comparatively scarce in East Africa, so that there appears to be no immediate prospect of this copal substitute becoming available in quantity, although it appears to offer a future for planting copal trees. With the meagre data at present available it is of course impossible to offer any opinion as to the industrial value of this material, but in view of Dr. Foelsing's observations it would be of interest to examine the fruits of other trees from which the copals of commerce are derived.

THE BIOLOGICAL-AGRICULTURAL INSTITUTE AT AMANI.

The current number of the *Berichte über Land-und-Forst-wirtschaft in Deutsch-Ostafrika* (1907, 3. 43) is mainly occupied with an account of the work done during the year 1906–1907 in the Imperial Biological-Agricultural Institute at Amani, which is under the direction of Dr. Stuhlmann.

Recently the cassava plantations in this German Protectorate have been affected by a "leaf-curl disease," which has spread rapidly owing to the planting of diseased embryos. No remedy can be suggested for it at present, but planters have been recommended to examine all young plants in the nurseries before these are planted out, and to destroy those which are not perfectly healthy. Attention is also being given to the different kinds of cassava grown by the natives, with a view to the elimination of the less fruitful kinds.

An interesting series of experiments on the germination of wattle seed is recorded, and it has been found that these seeds germinate much more regularly after being macerated for four or five days in sulphuric acid and then washed in water.

A systematic inspection of the "sisal hemp" plantations of the Protectorate has also been made, and a visit was paid by an official of the Institute to the Sansevieria plantations in British East Africa.

The experimental cultivation of economic plants in the Gardens of the Institute is being continued, and a list of all those under trial is given. These include numerous varieties of coffee from the chief coffee-producing regions of the world, and tobaccos rom Salonica, Maryland, Ohio, Pennsylvania, Hungary and Spain.

A great variety of rubber plants is being tried, including species of *Ficus* and *Landolphia.* Numerous plants yielding fibres or paper-making materials are being experimentally cultivated, and also spices such as cinnamon, cardamoms, peppers, vanilla and ginger. Among plants yielding essential oils, the following are being tried: lemon-grass, vetiver, cananga, camphor, cajuput, patchouli and white sandal-wood.

Fourteen of the principal oil-seed yielding plants are also being experimentally dealt with; of these *Aleurites triloba*, yielding kekuna or candle-nut oil, *Anacardium occidentale*, yielding cashew nuts, the oil palm, coco-nut, linseed, olive and castor may be mentioned, all of which appear to be growing well.

The following are the principal plants yielding tanning materials now being grown: silver wattle (*Acacia dealbata*), black wattle (*Acacia decurrens*), divi-divi (*Cæsalpinia coriaria*), mallet bark (*Eucalyptus occidentalis*), barbatimao bark (*Stryphnodendron Barbatimam*) (see p. 360), myrobalans (*Terminalia belerica*), and canaigre (*Rumex hymenosepalus*).

In spite of the comparatively slight commercial importance of vegetable dye-stuffs these products are also receiving some attention at Amani, and the following are being tried: annatto (*Bixa orellana*), logwood (*Hæmatoxylon Campechianum*), and henna (*Lawsonia inermis*).

A large number of timber-yielding trees, plants yielding edible fruits, drugs, etc., are also enumerated as having been successfully raised in the Gardens.

The work done in the chemical laboratory attached to the Institute included a number of analyses of samples of rubber produced in the Protectorate from *Manihot Glaziovii*, *Ficus elastica*, *Hevea brasiliensis* and the indigenous *Landolphias.* Some of the locally grown wattle barks were examined as well as the bark of an unidentified indigenous *Acacia*, which yielded 20 per cent. of tannin.

In connection with the use of bitter orange juice as a coagulation material for rubber latex, experiments have been made as to the possibility of extracting the essential oil from the orange rind, which is at present wasted, but it does not appear likely that this will be remunerative.

Herr Lommel of the Institute staff spent three months on

exploration work in the Unguu, Uluguru and Kaguru Mountains. A new mineral, which resembles rutile in appearance and contains 40 per cent. of titanium dioxide, 3 per cent. of thoria and 10 per cent. of ceria was collected in the course of this tour. Near Udjidji copper-bearing minerals were met with, one sample of which was found to contain 34·6 per cent. of the metal. From various places in the Protectorate samples of asphalt, supposed auriferous quartz, mica, titaniferous sand, salt-bearing earth and other mineral products were received for examination, but most of these proved of little or no value.

The report concludes with an interesting account of work done in the Zoological section, which is principally a record of observations on insect pests affecting economic plants in the Protectorate and of remedial measures advised against these.

OCCURRENCE AND USES OF TANTALUM.

OWING to the statements which have from time to time appeared in technical and scientific journals relating to suggested commercial applications of the metal tantalum, a considerable amount of interest has been shown in several British Colonies in the possibility of finding a market for tantalum ores, and as a number of enquiries have been addressed to the Imperial Institute on this subject it has been thought advisable to publish the information available on this subject in this *Bulletin*.

Metallic tantalum was until recently almost unknown in commerce, and its present prominence is due mainly to the discovery of its suitability for the preparation of filaments to be used in electric incandescent lamps.

TANTALUM ORES.

The most commonly occurring tantalum minerals are tantalite and columbite, which consist of tantalates and niobates of iron and manganese in varying proportions. Tantalite is rich in the metal and contains about 84 per cent. of tantalum pentoxide, whilst columbite contains but little tantalum and is mainly

composed of the practically worthless and often detrimental niobic pentoxide.

The specific gravity of the minerals is a rough but useful guide to the amount of tantalum present, as this factor increases with the percentage of tantalum pentoxide present. Columbite containing practically no tantalum has a specific gravity of about 5·3, whilst pure tantalite approaches 7·8. This point is well illustrated by the table of analyses of typical specimens of ore quoted subsequently.

Tantalite.—This is a black mineral, whose composition is typically represented by the formula $(Fe,Mn)Ta_2O_6$, in which the iron is frequently replaced, wholly or in part, by manganous oxide, and the tantalic oxide by tin, zirconium or niobic oxide. The hardness varies from 6 to 6·5, the streak is black, and the specific gravity varies from 6·5 to 7·3. It crystallises in the orthorhombic system.

Columbite.—This mineral is the form in which tantalum most commonly occurs. It is usually found associated with tantalite, and is essentially a niobate of iron and manganese, $(Fe,Mn)Nb_2O_6$, together with $(Fe,Mn)Ta_2O_6$. The streak is dark red to black. Its hardness varies from 5 to 6, being rather less than that of tantalite, and the specific gravity varies from 5·3 to 6·5. The crystals are usually orthorhombic prisms.

There are a number of other minerals in which tantalum occurs, but as they either contain but little of the metal or are of rare occurrence they are not of commercial importance at present, when there appears to be more than sufficient tantalite available to supply the requirements of manufacturers. A summary of the properties of these less important minerals may, however, be of interest in view of the possible extension of the use of the metal.

Fergusonite.—This mineral consists essentially of a meta-niobate of tantalum and yttrium. It usually occurs massive, and has a characteristic brownish-black colour. The amount of tantalum pentoxide present varies from 2 to 10 per cent., but occasional samples are met with containing up to 27 per cent. The mineral has an almost colourless streak and a specific gravity of about 5·8. It has been found, usually in granite and pegmatite dykes, in a number of localities, of which may be

mentioned—Ceylon ; Rockport, Mass. ; Amelia, Virginia ; and also in the mica mines in Mitchell Co., N. Carolina.

Samarskite.—This mineral, which is fairly abundant, consists of niobates and tantalates of iron, calcium, yttrium and cerium metals together with uranium oxide. It is usually found massive or in flattened, embedded grains in pegmatite dykes, or occasionally in well-developed rhombohedral crystals. The mineral possesses a velvet-black colour, dark reddish-brown streak, vitreous lustre, and a specific gravity of 5·6 to 5·8. In the Wiseman Mica Mine in Mitchell Co., N. Carolina, it occurs in masses weighing up to 20 pounds.

Yttro-tantalite.—This is a tantalate and niobate of iron and calcium, and the oxides of the metals yttrium, erbium, cerium and uranium. It contains about 46 per cent. of tantalum pentoxide, and varies in colour from brownish yellow to black. It has a specific gravity of about 5·8, and its hardness varies from 4·5 to 5. It is found in small quantities near Ytterby in Sweden.

Hatchettolite.—This is a tantalo-niobate of uranium with lime and a small quantity of iron. It is a yellowish-brown mineral with a resinous lustre, and usually occurs associated with samarskite. It contains about 29 per cent. of tantalum pentoxide.

Tapiolite.—This mineral contains about 74 per cent. of tantalum pentoxide, but has so far only been observed near Sukala in Finland. It occurs in tetragonal crystals possessing a black colour and streak, and an adamantine lustre. It has a hardness of about 6 and a specific gravity of 7·3 to 7·8.

Hielmite.—This is a rare mineral found in small quantities in the Kararfvet mine near Fahlun, Sweden. It is a stanno-tantalate of iron, yttrium, manganese and calcium, and contains from 52 to 74 per cent. of tantalum pentoxide. It is of a black colour, and gives a greyish-black streak. Its hardness is 5 and specific gravity 5·8.

Microlite.—This is essentially a calcium pyro-tantalate, and contains 68·5 per cent. of tantalum pentoxide. It is of a pale yellow to brown colour, and has a resinous lustre. It occurs sparingly in pegmatite dykes at Chesterfield, Mass. ; Branchville, Conn. ; Amelia, Virginia.

Stibio-tantalite.—The mineral is pale reddish-yellow in

colour, and has a nearly white streak and an adamantine lustre. Its specific gravity when pure is about 7·4, and its hardness 5 to 5·5. It occurs in the Greenbushes Tin Field, South Australia.

DISTRIBUTION OF TANTALUM MINERALS.

United States.—The tantalum-bearing minerals are mostly found in the eastern part of the United States; columbite being of more frequent occurrence than tantalite. The most promising locality is near Branchville, Fairfield Co., Conn., where columbite containing fair quantities of tantalum occurs in masses, weighing up to 5 pounds, associated with spodumene in a pegmatite dyke. In North Carolina, columbite and tantalite have been found in quantity in the mica mines of Mitchell and Yancey Co. Considerable quantities of the ore have been shipped to Germany from the mica and tin deposits of the Black Hills, South Dakota.

The composition of specimens of columbite and tantalite from various localities in the United States is shown in the following table:—

Locality.	Specific gravity.	Niobic pentoxide. Nb_2O_5.	Tantalic pentoxide. Ta_2O_5.	Ferrous oxide. FeO.	Manganous oxide. MnO.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Branchville, Conn. . . .	5·73	60·70	19·20	12·91	7·03
,, ,, . . .	6·59	30·16	52·29	0·43	15·58
Etta Mine, Black Hills, South Dakota	5·89	54·09	18·20	11·21	7·07
,, ,, ,, ,,	6·37	40·37	41·14	8·28	9·09
,, ,, ,, ,,	6·75	29·78	53·28	6·11	10·40
Yancey Co., North Carolina	6·88	23·63	59·92	12·86	3·06
Grizzly Bear Gulch, South Dakota	7·77	6·23	78·20	14·00	0·81

The above table well illustrates the effect of increased percentage of tantalum pentoxide on the specific gravity already referred to.

South Australia.—Tantalite occurs in the tin-bearing districts of the Northern Territory in the following localities—(1) on the Finniss river about 15 miles west of Rum Jungle, (2) in the West Arm district, three-quarters of a mile east of King's Table, (3) Bynoe Harbour district, 9 miles south of the

Leviathan, (4) on Horden and Paull's claim, three-quarters of a mile from the last-mentioned locality.

Samples from the Finniss river gave the following results on analysis :—

		Per cent.	Per cent.
Tantalic oxide	Ta_2O_5	41·70	55·52
Niobic oxide	Nb_2O_5	19·00	24·92
Manganous oxide	MnO	14·83	11·16
Stannic oxide	SnO_2	21·00	4·40
Ferrous oxide	FeO	2·14	2·72
Undetermined		1·33	1·27

The matrix in the Finniss river district consists of a huge intrusion of "greisen"; the outcrop measures 3 to 4 chains in width, and is about 6 chains long, being characterised by immense inclusions of compact white quartz. Tantalite occurs as small bunches and isolated crystals distributed throughout the mass, and assumes three modifications dependent upon the character of the matrix—(1) irregular inclusions, in the compact white quartz with no associated minerals; (2) radial spherical crystal groupings, in a rock of fine-grained texture; (3) regular rhombic crystals found in the normal matrix associated with tinstone.

The country rock is an arenaceous mica schist. The bulk of the ore, so far raised, has been obtained by surface work on the decomposed dyke, and its sheddings on the hill slopes.

West Australia.—The occurrence of tantalum was first noted in 1894 at Greenbushes, Bunbury, as stibio-tantalite (tantalate of antimony). Tantalite was found in 1900 in an alluvial wash from the same district. In 1904 material from Wodgina yielded mangano-tantalite, and in 1905 mangano-columbite and calcio-tantalite were found at Wodgina and Mount York (Chingamong). The production in 1905 amounted to 73 tons valued at £10,515, and in 1906 to 15 tons valued at £2,644.

The Wodgina district consists of a series of metamorphosed, sedimentary and igneous rocks, the latter being much faulted and pierced by granite and pegmatite veins. The tantalite occurs in the form of grains and rough pseudomorphous crystals in the felspathic lode. Formerly the ore was obtained from the out-

crops of the lode by dry-blowing, but this source of supply being now almost exhausted, the more expensive method of working the lode itself will have to be followed.

The following are assays made chiefly on bulk samples from various localities in this State.

Ore.	Locality.	Tantalic oxide. Ta_2O_5.	Niobic oxide. Nb_2O_5.
		Per cent.	*Per cent.*
Tantalite	Greenbushes	80·61	2·50
,, ...	,,	68·50	5·46
Stibio-tantalite . . .	,,	51·13	7·56
,, ,, . . .	,,	50·57	12·58
,, ,, . . .	,,	51·95	4·49
Mangano-tantalite . .	Wodgina	69·95	14·47
,, ,, . .	,,	72·46	6·80
Calcio-tantalite . . .	,,	73·82	6·44
Mangano-tantalite . .	Green's Well	57·46	27·24
Tantalite	Lalla Rookh	70·34	4·92

Individual fragments from the Wodgina field vary in specific gravity from 5·50 (10 per cent. of tantalum pentoxide) to 8·03 (84 per cent. of tantalum pentoxide).

Analyses of stibio-tantalite from West Australia have given the following results:—

		A. *Per cent.*	B. *Per cent.*
Tantalic oxide .	Ta_2O_5 .	51·13	51·95
Niobic oxide .	Nb_2O_5 .	7·56	4·49
Antimony oxide .	Sb_2O_3 .	40·23	38·04
Bismuth oxide .	Bi_2O_3 .	0·82	0·79
Nickel oxide .	NiO .	0·08	trace
Ferric oxide .	Fe_2O_3 .	trace	0·39
Manganous oxide	MnO .	trace	trace
Copper oxide .	CuO .	—	0·30
Silica . .	SiO_2 .	—	3·14
Water at red heat	H_2O .	0·08	0·61
Specific gravity		7·37	6·60

Tantalum minerals are also known to occur in the following localities, but these occurrences appear to be of little importance. Skogböll near Kimito, Finland; Brodlbö and Fahlun, Sweden; Rosendal near Björkboda, Haekaesaari near Tammela,

Norway; Sanarka district, Urals, Russia; La Vilatte near Limoges, France; Bodenmais, Bavaria; Creveggia, Italy.

COMMERCIAL VALUE OF TANTALUM MINERALS.

The value of tantalum minerals has shown great fluctuations since they began to be of commercial importance, and it is scarcely possible to give definite information on this point, as there are few manufacturers using these materials, and the market is limited. The ores appear to be bought on a basis of at least 60 per cent. of tantalum pentoxide, and the niobium oxide should not exceed 3 per cent. Chromium should be entirely absent. The price is stated to be about 4*s.* 6*d.* per kilogram for ore conforming to these requirements. The question of the presence of chromium does not seem to have been considered in most of the recorded analyses of these minerals.

EXTRACTION OF TANTALUM FROM ITS ORES.

The following process is said to be used by one of the principal makers. The tantalum in the mineral is converted into the alkali fluoride, which is then acted on by metallic sodium, yielding metallic tantalum together with a small quantity of tantalic oxide. The further purification of the metal is based upon the fact that when heated to whiteness it does not absorb oxygen unless the pressure of the gas exceeds 20 mm., and also that tantalum pentoxide is more volatile than the metal. In practice the spongy metal, obtained in the previous process, compressed into a crucible made of magnesia or thoria, is fused in a closed exhausted electric furnace. The crucible forms the anode, and the cathode consists of a rod of pure tantalum or silver, and is kept rotating during the passage of the current. The metal thus produced is compact and free from oxide.

PHYSICAL PROPERTIES OF TANTALUM.

Tantalum when pure melts at a temperature of about 2200°C., its hardness varies from 9 to 10, and it has a specific gravity of 16·5 to 16·6. A somewhat remarkable property of the metal is, that although very ductile under ordinary conditions, after

hammering it becomes extremely hard. Thus in one experiment a beaten sheet 1 mm. thick was drilled for 72 hours with a diamond drill making 5,000 revolutions per minute, with the result that a depression 0·25 mm. was produced in the sheet, and the drill was much worn. A use which naturally suggests itself from the result of this experiment is the employment of tantalum-edged drills in deep bore holes in place of those of "bort" (black diamond) now used. The tensile strength of the metal, when in the form of fine wire, amounts to about 95 kilos. per square mm., as compared with 85 kilos. given by the best steel. Thin wires when ignited in air burn with low intensity and without any noticeable flame.

CHEMICAL PROPERTIES OF TANTALUM.

In chemical properties tantalum approximates to gold and platinum. Boiling hydrochloric, nitric or sulphuric acid or *aqua regia* are without action on it, as also are aqueous solutions of the alkalis. It is attacked, however, by fused alkali or hydrofluoric acid; the latter acts slowly under normal conditions, but if the metal is in contact with platinum the action is rapid. Tantalum does not amalgamate with mercury. At a low red heat it rapidly absorbs nitrogen and hydrogen, forming compounds having a metallic appearance. It also combines readily with carbon.

USES OF THE METAL.

The suggested uses for tantalum cover many branches of industry where a metal of great hardness, high-melting point and freedom from attack by the majority of chemical reagents is required. The importance with which future applications of the metal is viewed by the pioneers in its production on a commercial scale, may be judged by the fact that during the last three years over 200 patents have been secured by them.

Tantalum lamp.—This is at present the application most frequently met with. It is the outcome of experiments carried out by Dr. von Bolton of Berlin, with a view to securing a metallic filament capable of replacing that of carbon used in electric incandescent lamps. The chief advantages of this lamp are

stated to be (1) its high efficiency of 1·5 to 2 watts per candle power, compared with 3·0 watts required by lamps with a carbon filament, (2) the whiteness of the light produced, which approximates to that given by acetylene, and (3) that a current considerably in excess of the normal can be sent through the filament without it burning through.

The wire used for a 25-candle-power lamp measures about 0·05 mm. in diameter, is 65 cm. long, and weighs 0·022 gm., so that one kilogram of tantalum will suffice for 45,000 filaments. The filaments are not arranged in the spiral fashion usual with carbon filaments, but are wound up and down on two series of hooked glass arms. The filaments are stated to be produced by drawing the metal between diamond points.

An interesting point about these lamps is that when the filament burns through, the usefulness of the lamp is not at an end, as by gently tapping the lamp so as to bring the broken strand into contact with one of its neighbours contact may be re-established and the circuit completed.

Tantalum alloys.—There are stated to be several difficulties met with at present in the manufacture of tantalum alloys on a commercial scale, but no doubt these will be surmounted as the industry progresses.

Iron alloyed with 5 to 10 per cent. of tantalum is very hard and yet ductile; the same being true of alloys with molybdenum and tungsten when the tantalum does not exceed 5 per cent.

Traces of carbon, boron, silicon, tin or titanium are said to increase the hardness of tantalum without materially decreasing its ductility, but more than 1 per cent. of carbon renders the metal so brittle that it cannot be drawn into wire. Aluminium has the same effect. The use of tantalum, containing traces of the above-mentioned metals, for the manufacture of cutting edges, tools, surfaces, points, watch-springs, pens and anvils is covered by patents. The pens are stated to consist of 95 to 98 per cent. of tantalum together with from 2 to 5 per cent. of iron or tungsten. The hardening can be accomplished by heating the pens whilst embedded in powdered charcoal.

Another suggested use for this metal is its employment as a substitute for platinum in the manufacture of dishes and crucibles for chemical work. It is inferior to platinum

inasmuch as it is attacked by hydrofluoric acid and fused alkali, and oxidises when heated in air, but it has the advantage of being unattacked by *aqua regia*.

The following are the principal sources of information on tantalum and tantalum minerals at present available.

Report of the Government Geologist, South Australia, 1905.

Geological Survey of Western Australia, Bull. No. 23.

Mining Journal, September 29, 1906.

Electrical Review, January 27, 1905.

Revue Scientifique, July 1907.

Dana's Mineralogy.

Mineral Resources of the United States (United States Geological Survey), 1904, 1905 and 1906.

Engineering, September 1, 1905.

Electro-chemical and Metallurgical Industry, 1905, p. 135.

GENERAL NOTES.

African Wild Silks.—Specimens of a wild "silk" were recently forwarded from Uganda, and have been examined in the Scientific and Technical Department.

The silkworm (*Anaphe* sp.) feeds principally on the leaves of species of *Ficus*, but the cocoons are found in almost all the forest trees. The caterpillars spin a large nest, inside which they form their cocoons in considerable numbers. These nests are composed entirely of "silk"; the outer layers are of somewhat loose texture, whilst the inner part is firm and paper-like, but on degumming, each portion yields the same silky material. It seems probable that the whole of this product may be capable of utilisation as "waste" silk. On examining the cocoons it has been found possible to reel a small quantity of silk from selected specimens, but usually they are too loose to allow the reeling to be satisfactorily carried out.

Technical trials have shown that the whole of the silk can be spun into lustrous yarns which can be dyed without difficulty.

Similar cocoons have been received from Southern Nigeria, Northern Nigeria and Nyasaland. In Southern Nigeria the silk is used by the natives in conjunction with cotton for making the so-called "soyan" cloths.

There appear to be several varieties of these silkworms, and they

probably occur in many parts of Africa. The following information, with reference to their identification, has been obtained.

The silk cocoons of Southern Nigeria used for the "soyan" cloths are those of *Anaphe infracta.* A better known species, *Anaphe panda*, occurs in Natal and produces similar nests of cocoons. *Anaphe venata* has been found to the west of Kumassi, *Anaphe ambrizia* is recorded from Northern Nigeria, Uganda and Mashonaland, and *Anaphe Maloneyi* has been observed in Uganda and Southern Nigeria.

If the rearing of these silkworms is undertaken as a native industry, precautions will have to be taken against parasites. Certain species of *Anaphe* appear to be attacked by an ichneumon fly which passes its larval period inside the silkworm, destroying the host and utilising the chrysalis as a protection for its own pupal stage. The entire subject is still under investigation.

"Gift-bol" Fibre from the Transvaal.—The so-called "gift-bol" is the large bulb (somewhat resembling a Spanish onion) of *Buphane disticha*, a plant of the natural order *Amaryllidaceæ*, which grows freely in the Transvaal and Orange River Colony. The plant is particularly adapted to dry districts since it is capable of putting out roots of a great length, and can thus obtain a supply of moisture which would otherwise be denied.

A sample of the bulbs was forwarded to the Imperial Institute from the Transvaal in order that an examination might be made of a peculiar fibre they contain. A specimen of this fibre was extracted from the bulbs, and was found to be white, silky, lustrous, rather weak, and soft and limp to the touch. The individual fibres had a maximum length of 1·5 inches, but generally varied between 0·4 inch and 1·0 inch. Their diameter was found to be about $\frac{1}{10000}$ inch, and the fibre is therefore about eight times as fine as ordinary cotton or four times as fine as silk. The filaments are grouped together in coils or twisted bundles, and these have a diameter varying from $\frac{1}{4000}$ to $\frac{1}{2000}$ inch. On chemical examination the fibre was found to contain 9·4 per cent. of moisture and 70·8 per cent. of cellulose (calculated on the dried material).

The reports of technical and commercial experts to whom specimens of the fibre were submitted confirmed the conclusions arrived at by the Scientific and Technical Department of the Imperial Institute, and may be summarised as follows.

It is improbable that the "gift-bol" fibre could be used for purposes similar to those to which cotton and silk are applied, for owing to the extreme fineness of the fibre, cotton preparing and spinning machinery would be quite unsuitable for dealing with it, whilst the shortness of the fibre would preclude its being worked by "waste-silk" or "spun-silk" machinery. It is possible that, without isolating the individual filaments of the material, the groups of fibres might be spun, but the resulting yarn would be very coarse and could only be used as a substitute for

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"cotton waste" yarn or similar materials. It appears, therefore, that this fibre will be of little value as a textile raw material.

Cotton from Cape Colony.—Two samples of cotton have been forwarded recently to the Imperial Institute from Cape Colony and are of interest as representing varieties of cotton which could be grown in quantity if a sufficiently remunerative price could be realised.

Sample A, grown in Griqualand West, consisted of clean, ginned cotton, free from stains but of uneven colour, varying from light-reddish to cream. The product was soft, silky and lustrous, and of normal strength. The sample evidently consisted of a mixture of two varieties, apparently Sea Island and brown Egyptian, one of which was from 1·6 to 2·1 inches long and 0·0004 to 0·0008 inch in diameter, whilst the other was from 1·0 to 1·6 inches long and 0·0005 to 0·0010 inch in diameter. Both varieties were of satisfactory quality, and if care were taken to keep them distinct they would be readily saleable. The mixed product was regarded as worth about $9\frac{1}{2}$*d.* per lb., when "fully good fair" brown Egyptian cotton was quoted at $10\frac{5}{16}$*d.* per lb.

Sample B, grown at Port Elizabeth, was of the Sea Island variety, and consisted of clean, ginned cotton of an even cream colour. The material was soft, silky, very lustrous, and of fairly good strength. The cotton was 1·5 to 2·1 inches long and 0·0004 to 0·0008 inch in diameter. This sample was of promising quality and would be readily saleable at about 1*s.* per lb.

Agricultural Progress in the Federated Malay States.—The special supplement to the Perak Government Gazette, containing the Federal Reports for 1906, gives some particulars of recent work done in the States in the way of agricultural development.

The feature of the year, it is stated, has been the extension of rubber cultivation (*Hevea brasiliensis*); the estimated area alienated for rubber being 200,000 acres, and that planted 85,000 acres as against the corresponding amounts of 100,000 acres and 50,000 acres for the previous year. The number of rubber estates was 242, and the quantity of dry rubber produced 861,622 lb. The number of trees per acre varies from 50 to 440, and on more than one-third of the area planted the number is 200. Planters are beginning to realise that insufficient room has been allowed to rubber trees in the past, and the practice is now becoming general of planting in avenues 24 by 30 feet or 20 by 17 feet. Disease appeared in some nurseries and attacked some of the older trees, but the general health of the rubber trees was excellent. The Director of Agriculture expresses the opinion that there are still very large areas available, which are as well, or better, adapted to rubber cultivation as the land already taken up for this purpose. Much attention is being given to the form in which the rubber is prepared for the market, and buyers, it is stated, appear disposed to prefer what is known

as "block rubber" to the forms hitherto in vogue, viz. sheet, crêpe and biscuit.

Experiments are being made in the cultivation of the sensitive plant (*Mimosa pudica*) in rubber plantations to replace the useless weeds, which grow there naturally in profusion at present and entail the expenditure of much labour for weeding. It is thought that the sensitive plant might oust these weeds and be used as a green manure, being ploughed into the land periodically.

The area under coffee decreased considerably, probably as the result of the greater attention now being given to rubber.

The area under cocoa-nuts increased by only 5 per cent. during the year. Considerable damage was done by beetle pests in Selangor and a little in Perak and Negri Sembilan.

Experiments are now being made in the propagation of camphor trees from cuttings at the Bata Tigu Experiment Station, and the results are said to compare favourably with those secured in Ceylon.

The chemist attached to the Medical Research Institute has been engaged during the year mainly in devising a portable apparatus for the manufacture of carbon disulphide to be used as an insecticide, and in investigating the effects of the arsenical sulphur dioxide fumes, produced in the smelting of tin, on vegetation.

Agriculture in the Atacama Desert of Chile.—In the course of an account of a tour through the Atacama desert, which is the centre of the nitrate industry of Chile (see this *Bulletin*, 1907, **5**. 91), Dr. Simon of Santiago de Chile gives some interesting notes on the agricultural operations carried on in the oases of Pica and Matilla and the methods adopted in raising crops on the rainless, salt-encrusted plateau itself. The first of these oases has had a system of irrigation since the time of the Spanish occupation, the water being derived from subterranean supplies and distributed in a system of canals about 3 kilometres long. This water as it reaches the air has a temperature of about 40°C., and has long been supposed to possess curative properties. The oasis of Matilla is supplied with water from a small stream flowing down from the Cordilleras, and which is distributed by means of irrigation canals.

In Pica vegetables and fruits of various kinds are grown and especially grapes, and from these is made the Pica wine, which is well known throughout Chile. These oases are the source of the scanty supply of fruit and vegetables available for the workers engaged in the nitrate industry. In addition to these and other oases of the same type, having an actual water supply, other centres of cultivation known locally as "canchones" are found. The formation of these is possible owing to small subterranean supplies of water derived from the Cordilleras, which are sufficient for the cultivation of certain types of plants, notably algaroba, alfalfa, tamaraga and algarobilla.

In cultivating the "canchones" long parallel trenches are dug, the salt-encrusted earth removed in this operation being heaped up on either

side. The width of the trenches varies directly with the moistness of the soil and the humidity of the atmosphere, and the depth depends on the thickness of the salt crust. Dung and Peruvian guano are used as manures.

In these trenches are placed young plants raised in special nurseries, and in addition to the plants named above small quantities of oats, tomatoes and water-melons are grown in this way. The algaroba furnishes a sweet pod, which is eaten raw by the inhabitants, and its timber is used as fuel. The algarobilla yields the well-known tanning material of the same name, in which a considerable export trade is still done.

Chemistry and Canadian Agriculture.—Mr. F. T. Shutt, chemist to the Canadian Department of Agriculture, delivered a lecture bearing this title to the Agriculture Section of the American Chemical Society which met at Toronto on the 27th June of the present year. The lecture is reprinted *in extenso* in *Science* (1907, **26**. 265), and from this source the following points of general interest mentioned by Mr. Shutt are taken. As an indication of the enormous increase in the production of grain in Canada which has taken place in recent years, it was mentioned that the area under cereals in the provinces of Manitoba, Saskatchewan and Alberta had risen from 3,491,414 acres in 1900 to 6,025,190 in 1905, and 7,894,686 in 1906; the outputs for the same three years being 43,251,662, 162,244,929 and 239,841,001 bushels respectively. Dr. Saunders, Director of the Dominion Experimental Farms, estimated that in the same three provinces the land under cultivation in 1904 only amounted to 5,000,000 acres out of a possible 171,000,000 acres.

The progress made in agricultural development is, in Mr. Shutt's opinion, largely due to the work done by the Agricultural Colleges and to the Experimental Farms established by the Dominion Government. The experimental farm system comprises a central institution at Ottawa with a scientific staff and laboratories and branch farms in Nova Scotia, Manitoba, British Columbia, North West Territory and in Northern and Southern Alberta.

One of the chief problems likely to affect agriculture in Canada in the future is that of the gradual impoverishment of the soil resulting from the system of cultivation in vogue in some parts. This problem, though not acute at present, is of serious import for the future, especially as regards the Eastern Provinces, and the Department of Agriculture since its inception has devoted special attention to this question of the economic maintenance of soil fertility. As an indication of the sort of effect produced on soils by continued growth of grain, an instance is quoted of a plot of ground on the Experimental Farm at Indian Head, which has been under observation since 1883, and from which six crops of wheat, four of barley, and three of oats have been taken, with a fallow year between each crop since 1887. The virgin soil near this plot

contains 3,824 lb. of nitrogen per acre in the top four inches of soil, whilst in the same depth of the cultivated plot there is only 2,402 lb., *i.e.* a loss of 1,422 lb. per acre. The available nitrogen is still very large and the plot still bears excellent crops of cereals, but it is obvious that continued grain cropping would eventually seriously impair its fertility. As a remedial measure Mr. Shutt thinks that recourse must be had to leguminous crops, which not only enrich the soil in nitrogen but when used as green manure supply humus-forming material and set free by their decomposition other important plant constituents, such as potash, phosphoric acid and lime.

Among other important subjects which have been investigated by the Department of Agriculture, and have called for the application of chemical knowledge in recent years, have been the effect of different feeding-stuffs on the quality of pork, the preservation of barnyard manure, the conservation of moisture in soils, reclamation of swamp muck soils, of which there are large areas in Canada, and the determination of the relative values of forage crops.

The Burning Quality of Tobacco.—One of the principal difficulties which besets the planter in attempting the cultivation of tobacco in new localities is that of securing a product which will burn well. A good tobacco should, when once ignited, continue to glow without producing any flame, and should leave a white or at most a greyish-white ash. Further, it should not carbonise and form what is technically known as a "black lip" just in advance of the ash. Though chemists have long been engaged in investigating the causes which determine good or bad "burn" in tobacco, the problem is so complex that the whole of the factors which influence it are not yet known. It is, however, tolerably certain now that the burning quality of tobacco is most influenced by the nature of the mineral matter contained in the leaf.

The present condition of this problem is discussed in *Bulletin* No. 105 issued recently by the Bureau of Plant Industry of the United States Department of Agriculture, in which Mr. W. W. Garner recounts the results of a number of experiments he has made with a view to the solution of this question.

From these results the following conclusions are drawn. (1) The fire-holding capacity of tobacco is dependent primarily on the amount of potassium, in combination with organic acids, present; (2) lime in general does not greatly affect the fire-holding capacity, but is an essential factor in the production of a good ash; (3) large amounts of magnesia tend to injure the capacity for holding fire; (4) chlorine injures the burning quality, and so also do sulphates, but the latter have less effect in this direction than chlorine; (5) so far as is known none of the organic constituents of tobacco, with the possible exception of the so-called tarry acids and the albuminoids, exerts a very important influence on the burning quality.

It has long been known that tobaccos yielding ash rich in potash are

usually of satisfactory burning quality, and hence the recommendation of potassium sulphate or decaying leaves (usually fairly rich in potash) as manure in localities known to produce tobacco of poor-burning quality; but in view of Mr. Garner's results it seems desirable that potash should be applied in some other form than the sulphate, and of the potash salts available Mr. Garner suggests the silicate as that most likely to give good results. The chloride (kainit) and nitrate are of course inadmissible, the former because it introduces the undesirable constituent chlorine, and the latter because it induces a coarse, rank growth.

The use of manures containing magnesia is obviously also inadvisable. In so far as the organic constituents, tarry acids and albuminoids, which alone appear to affect the burning quality, are concerned, it should be remembered that the amount of the latter present is usually proportioned to the luxuriance and vigour of the plants, so that tobacco of rank growth is liable to contain excess of these constituents. Since the percentage of albuminoids diminishes rapidly during the ripening process after the leaf is fully grown, it is important that the leaves should not be collected until they are well-ripened.

The amount of albuminoid matter is also greatly affected by the processes of "curing" and fermentation, so that the burning quality is still further improved when these processes are properly conducted.

Mercury Deposits of the Transvaal.—The importance of mercury to the gold industry of South Africa is shown by the fact that the Transvaal imported, during 1906, 146,412 pounds of mercury valued at £12,346. The occurrence of deposits of cinnabar in the Colony is therefore a matter of considerable interest, and possibly of commercial importance, when it is remembered that the world's production of this metal shows a tendency to diminish, and in 1905 amounted only to 3,300 tons. The present price of the metal is £7 per flask of 75 pounds. Cinnabar (mercuric sulphide) has for some time been known to occur in the Eastern Transvaal, in the Marico and Rustenburg districts and near Pietpotgietersrust. One of the most promising occurrences is that on the Buffels Spruit, a tributary of the Lomati river, about twelve miles south of Malelane station on the Delagoa Bay line. The cinnabar occurs as a vein which has been traced over a considerable distance, and is associated with a quartzose gangue in a sericite schist.

According to the *South African Mines* (July 13, 1907), a company has recently been formed to work another promising deposit, which is situated about eighteen miles from Hector Spruit on the Delagoa Bay railway. This occurrence is of special interest, since the metal occurs both native and as cinnabar. As the result of some prospecting done along the banks of an adjoining creek, it is stated that many pockets of native mercury have been disclosed carrying about four ounces of gold per ton. It is stated that two days' sluicing yielded 40 pounds of the metal.

NOTICES OF RECENT LITERATURE.

NEW BOOKS.

THE WILD AND CULTIVATED COTTON PLANTS OF THE WORLD. A revision of the genus *Gossypium* framed primarily with the object of aiding planters and investigators who may contemplate the systematic improvement of the cotton staple. By Sir George Watt, C.I.E., M.B., C.M., LL.D., F.L.S., etc. Pp. xiv. + 406, with 53 illustrations. (London, New York, Bombay, and Calcutta : Longmans, Green & Co., 1907.)

This work is the outcome of an extended study of the cotton plant, carried out both on the living plants and also on the dried specimens contained in various herbaria. The author, during his thirty years' residence in India, travelled over the whole country in his official capacity as Reporter on Economic Products to the Government of India, and was able to make copious observations on the various forms of cotton which he encountered.

The book is divided into four chapters, which deal with (i) the history of cotton and the cotton industry, (ii) the cotton fibre, (iii) the species, varieties and races of the cotton plant, and (iv) the improvement of stocks by cultivation and hybridisation. In an appendix, the many specimens are enumerated which were examined in the course of preparing the work, a bibliography is given of the authors consulted, and a list of the species and varieties of *Gossypium* with their synonyms is added. The book is illustrated with numerous plates, including several (half-natural size) reproductions by the three-colour photographic process.

The greater part of the book is occupied by the third chapter, in which an endeavour is made to classify cottons on a rational and consistent system. This has been a most arduous task, owing to the great confusion caused by the indiscriminate manner in which scientific names have been applied. The author has sought to ascertain who the botanist was who first used each particular name, and to find the actual specimen to which he applied it. It is considered that this rule of priority is the only method of avoiding chaos. Unfortunately, the first species to be named were cultivated plants studied by Linnæus. Since that time it appears to have been frequently assumed that no wild species of *Gossypium* existed, and consequently when such were found they were classified on the basis of the five or six Linnæan types. The fact that cotton has been cultivated from prehistoric times and the consequent impossibility of determining with any degree of certainty the origin of some of the principal commercial varieties have still further complicated the problem.

The classification which the author has adopted is based primarily

on the hairy coatings of the seed. The species are referred to the following five sections. I. Species with a fuzz but no floss (ordinary cotton fibre). This section comprises certain wild species distributed from the western coast tracts and islands of America to Australia. II. Species, the seeds of which bear both fuzz and floss, and which have united bracteoles. This section includes species from which various Indian and other Asiatic cottons are derived. III. Species with seeds bearing both fuzz and floss and which have free bracteoles. This comprises various American species and one African but no Asiatic forms. IV. Species bearing floss but no fuzz and which have the bracteoles free or nearly so and the floral glands conspicuous. This section contains the species from which most of the commercial Egyptian and Sea Island cottons appear to have originated. V. Species bearing floss but no fuzz and having the bracteoles quite free and floral glands absent. There is only one species in this section, viz. *Gossypium Kirkii*, which is indigenous to East and Central Africa, but has never been observed under cultivation.

Among the many interesting points which have been brought out by the author's researches, reference may be made to the statements relating to the origin of Sea Island cotton. The botanical characteristics of this plant suggest that it originated from a parent form indigenous to South America, and it is considered probable that the modern form is a hybrid. It is practically certain that the original stock was not indigenous to the West Indies, and the plant was unknown to the early West Indian botanists. The statement frequently made that the plant is indigenous to the West Indies appears to be incorrect, although of course it has been abundantly proved that this cotton can be grown there with great success.

The last chapter dealing with methods of improving the cotton plant is most important, and should be carefully studied by all who are interested in cotton planting.

BAUMWOLLENKULTUR IN DEUTSCH-OSTAFRIKA. By H. Akmuth. Pp. 32, with 13 illustrations. (Arnsberg: Verlag von J. Stahl, 1907.)

This pamphlet, after describing the conditions required for the successful growth of the cotton plant and giving an account of the structure of the fibre, proceeds to discuss the suitability of German East Africa for cotton cultivation. Records of the average annual rainfall of the various districts are given, together with a statement as to the months of greatest and least precipitation. The northern coast districts are regarded as unfavourable, whilst the southern coast districts are considered to be much more suitable. The central district, however, affords the best conditions for the establishment of the industry.

Hitherto the cultivation of cotton in German East Africa has only been carried on by the natives, with the exception of the plantations which have been started in the districts of Kilwa and Saadani. The author puts forward suggestions for the establishment of an extensive

cotton industry, and in connection therewith discusses the subjects of irrigation, manuring, and means of transport.

MODERN FLAX, HEMP, AND JUTE SPINNING AND TWISTING. A Practical Handbook for the Use of Flax, Hemp and Jute Spinners, Thread, Twine and Rope Makers. By Herbert R. Carter. Pp. xiii. + 206, with 92 illustrations. (London: Scott, Greenwood & Son, 1907.)

This book is written on similar lines and covers much the same ground as the author's *Spinning and Twisting of Long Vegetable Fibres*, a notice of which appeared in this *Bulletin* (1905, **3**. 104). The present work, however, does not include the manufacture of ramie yarns.

CELLULOID: ITS RAW MATERIAL, MANUFACTURE, PROPERTIES AND USES (by Dr. Fr. Böckmann): English translation from third revised German edition. By Chas. Salter. Pp. vi. + 113, including plates and index. (London: Scott, Greenwood & Son, 1907.)

It is obvious that in a book of this size the subject can only be discussed briefly.

About one-third of the volume is devoted to the raw materials, cellulose and camphor, and to the methods of converting them into celluloid: the remainder of the book is taken up by an account of the properties and uses of the product.

A short chapter deals with the testing of celluloid, and some attention is given to the preparation and use of pyroxylin in the manufacture of artificial silk. The chemical composition of celluloid is briefly discussed.

The work seems inadequate to serve as a "Handbook for Manufacturers of celluloid and celluloid articles," and it would be more useful for practical purposes if the details of the methods and processes employed were given more fully.

THEOBROMA CACAO OR COCOA. By H. Wright. Pp. xii. + 249. (Colombo: A. M. & J. Ferguson, 1907).

The author, formerly the Controller of the Experiment Station, Peradeniya, Ceylon, has brought together in this book a useful summary of our knowledge regarding the botany, cultivation, chemistry and diseases of the cocoa tree. The Experiment Station when added to the Royal Botanic Gardens, Ceylon, was to a very large extent under cocoa, and much work was carried out in combating diseases and generally improving the "sanitation" of the crop. The conditions also allowed of detailed observations being made as to the periodicity of the plant in flowering, fruiting, etc., results of various methods of manuring, and many other matters of practical importance. Much of this work has been published already elsewhere, but the summarised results are incorporated in this volume in their appropriate places.

In addition, information has been compiled on all phases of cocoa

cultivation, using the term in a wide sense, in other parts of the world, with the result of supplying a book which should be of interest to cocoa growers. To the general reader also the illustrations of characteristic scenes on cocoa estates in Ceylon will be welcome.

The comprehensive nature of the manual may be gauged perhaps more readily by noting briefly some of the more important sections.

The history of cocoa and of the early experimental attempts to spread its cultivation in other countries is followed by a review of the climatic conditions prevailing in some of the chief cocoa-producing countries. The botany of the plant and allied species, and the chief varieties known in cultivation are fully described. The periodicity of various functions, already referred to, are then dealt with. Cultivation, harvesting, fermenting, drying and other stages in the preparation of the finished product, together with much information on soils, manuring, comparative yields, and the diseases of the plant occupy the greater portion of the book. In the section on manures special attention is given to green manuring, on which a considerable amount of experimental work has been done in Ceylon.

The remarks on the mixed cultivation of cacao with various rubber trees are of considerable interest at the present time.

A brief review of the world's production and consumption, the principal processes in the manufacture of cocoa and chocolate for human consumption, and directions for transporting young plants and seeds conclude what should be a useful volume.

KAFFEE, KAFFEEKONSERVEN UND KAFFEESURROGATE (Chemisch-technische Bibliothek, Band 297). By Erwin Franke. Pp. viii. + 221, with 32 illustrations. (Vienna and Leipzig: A. Hartleben's Verlag, 1907.)

This work gives an account of the coffee plant and its distribution, the methods of obtaining the coffee beans from the fruits, the chemical composition and analysis of the beans, the varieties of coffee met with in commerce, the preparation of coffee for the table, the grading of coffee, and the manufacture of coffee extracts.

A large part of the book is devoted to the subject of coffee substitutes, and an interesting account is given of their preparation and of the various materials employed in their manufacture, together with a description of the methods of packing the products and the detection of adulterants or objectionable ingredients.

The work is very complete, and will doubtless be of considerable value to coffee exporters, manufacturers, and merchants, and to coffee experts generally.

LES PLANTES TROPICALES DE GRANDE CULTURE. By É. de Wildeman, Tome I. pp. viii. + 387, with 64 figures in the text and 22 plates. (Brussels: Alfred Castaigne, 1908.)

In 1902 Dr. Wildeman published, under the same title, a book dealing with the useful plants of tropical Africa. The present volume may be regarded as a second edition of its predecessor, but it has been greatly enlarged, to enable the recent additions to our knowledge of the economic plants of the Congo in particular to be included. In the acquisition of this knowledge the Botanic Garden of Brussels, of which Dr. Wildeman is the director, has played an important part.

The first portion of the book is devoted to a general account of the botanical features of tropical Africa, and a more detailed study of the Congo region. The latter is divided into seven zones, whose limits are defined and the dominant characteristics of their vegetation described. The chief economic products are then enumerated and grouped according to their uses.

This introductory portion is followed by a detailed account of coffee, cacao, vanilla, cola and bananas. A large amount of information regarding these products is brought together in a form which should make it useful to all interested in tropical agriculture in any part of the world, although, as before, special attention is given to West African conditions. A useful feature of the book is the enumeration of the species and varieties of Caffea, Theobroma, Vanilla, Cola, and Musa, with, in most cases, full synonomy, references to published descriptions, and notes on geographical distribution.

PRACTICAL COAL-MINING. By Leading Experts in Mining and Engineering, under the Editorship of W. S. Boulton, B.Sc., F.G.S. Divisional-Volume **3**. Pp. vi. + 192. (London: The Gresham Publishing Company, 1907.)

This volume maintains the high standard set by its predecessors. Professor Thompson, of the University of Leeds, deals in an exhaustive manner with the subject of underground haulage, and in the succeeding section Mr. Charles Latham, of the University of Glasgow, treats of winding and pit-head gear in considerable detail. This is followed by the opening pages of Mr. Lishman's article on pumping, which will be continued in volume four.

AUSTRALIAN MINING AND METALLURGY. By Donald Clark, B.C.E. Pp. viii. + 534, with numerous illustrations. (London: Sir Isaac Pitman & Sons, Ltd., 1907.)

This is not a textbook, but a collection of articles arranged according to the States of the Commonwealth with which they deal.

The greater part of the space is devoted to particular mines and metallurgical installations, but the book concludes with more general articles on the choice of mining machinery, on gold assaying and refining, and on mining and metallurgical costs.

Although making no pretension to completeness it contains a large amount of valuable information, which is rendered available by a good index.

MATERIALS FOR A FLORA OF THE MALAYAN PENINSULA. Part II., pp. 235. Part III., pp. 197. By H. N. Ridley, M.A., F.R.S. (Singapore: Methodist Publishing House, 1907.)

The general scope of this useful work has already been described in the notice of Part I. (*Bulletin of the Imperial Institute*, 1907, **5**. 314). Part II. deals with seventeen natural orders of the Monocotyledons, the principal being the Zingiberaceæ, Liliaceæ, Commelinaceæ, Palmæ, and Pandanæ, all of which are strongly represented in Malaya as in other moist tropical regions. The orders Araceæ, Cyperaceæ and Gramineæ occupy practically the whole of Part III., the other two orders dealt with being the Lemnaceæ and Eriocauloneæ. The portions of the work now published complete the Monocotyledons.

Copious notes on economic matters are given under the plants to which they refer, and, as native names are added as well, the whole will form a work of reference invaluable not only to those interested in purely botanical questions, but also to those who have to deal with the economic uses of the plants of this region.

RULES FOR MICA MINING IN THE MADRAS PRESIDENCY. Pp. 35. (Madras: Government Press, 1907.)

These rules contain the conditions under which prospecting licenses and mining leases are granted. The term prospecting license is somewhat a misnomer, for the license is confined to an area which must not be more than a square mile or less than ten acres, and a rent is exacted equal to the land assessment, but not exceeding one rupee an acre. The license only continues in force for one year, but may, at the discretion of the Government, be continued for a period not exceeding two years. The licensee is allowed to remove a hundredweight of mica free of charge, but must pay duty at the rate of 5 per cent. on the value of any excess, calculated on the scale prescribed for the time being, which is based on the size and quality of the sheets.

He may also remove free of royalty for the purposes of experiment or as specimens 200 gallons of oil, 5 tons of auriferous quartz or silver ore, 2 cwt. of corundum of the coarser qualities (excluding the gem forms of the mineral), 1 ton of steatite, 10 tons of coal, ironstone, dressed ore of other metals, phosphatic nodules, magnesite, chromite, manganese or graphite, and 1 cwt. of rock crystals. If any excess be taken a royalty must be paid, which amounts to one anna (a penny) per ton in the case of coal, eight annas per 40 gallons of oil, $7\frac{1}{2}$ per cent. on the net profits in the case of gold or silver, half an anna per ton on iron ores and manganese, $2\frac{1}{2}$ per cent. on the value of dressed ore of other metals, and on graphite, corundum (coarser qualities), magnesite and chromite, 10 per cent. of the value of precious stones, and 5 per cent. on the other minerals enumerated.

A mining lease is strictly confined to mica. It may include one or more blocks, but the total area must not exceed ten square miles. The length of a block must not be more than four times its breadth,

and its area is limited to half a square mile. The term is in all cases thirty years. The lessee must pay 5 per cent. duty, on the official scale already referred to, on the mica raised, or a dead rent of one rupee per acre, whichever may be largest.

REPORT ON THE BELL MOUNT AND MIDDLESEX DISTRICT, TASMANIA. By the Government Geologist (W. H. Twelvetrees). Pp. 32. (Tasmania: Government Printer, 1907.)

This district is situated in the south-west of Devon county, Tasmania, and near the junction of the Forth with its tributary the Dove. The mining field, which is accessible *via* Sheffield and Wilmot, consists of silurian strata, overlaid in part by tertiary basalt, and penetrated by granite and quartz-porphyry, usually considered to be of devonian age. Still older rocks (pre-silurian) occur at Bell Mount, which is formed of ancient schists, flag-stones, and quartz-porphyries. The granite is everywhere to be regarded as the factor governing the mineralisation of the rocks in this field. Although lodes may be met with in the sedimentary strata, the metals which they contain (tin, tungsten, bismuth, molybdenum, copper, lead, gold and silver) obviously had their source in this granite magma.

The deposits which are met with in this district are: 1, pyrito-spathic lead veins; 2, pyritic lead veins; 3, quartz-topaz-bismuth-wolfram-cassiterite veins; 4, quartz-bismuth-tungsten veins; 5, tin-bearing stockworks in granite and quartz-porphyry; 6, cupriferous quartz veins; 7, pyritic gold quartz veins; 8, alluvial deposits of gold, tin and wolfram.

In the Shepherd and Murphy mine lodes occur in metamorphosed limestone and sandstone carrying tin, wolfram, bismuth and a little molybdenite. In number six lode of this mine the economic minerals are cassiterite, wolframite and bismuthinite, in varying proportions. The concentrates assay about 33 per cent. each of tin and wolfram, and have an average value of £100 per ton, which would give a value of £3 to each ton of crude ore. In the hill in basaltic alluvial clay are boulders of cemented conglomerate, containing layers or bands of coarse black tin oxide, accompanied by some topaz.

The lode at the All Nations wolfram mine is in sandstone (or quartzite), and contains wolfram, while, on the same property, tin and wolfram are disseminated in the quartz-porphyry. The lode in the sandstone (or quartzite) also contains a little gold, bismuth, and a minute quantity of molybdenite. It is probable that the Shepherd and Murphy number six lode (tin-wolfram-bismuth), and the All Nations wolfram lode are either identical or connected. This lode is one of the most remarkable in the State, consisting of combed quartz crystals throughout, some being as large as fourteen inches in circumference. Some of these crystals are pellucid, others are of the smoky variety. The lode mineral is the tungstate of iron, known as wolfram. A feature of the ore in this lode

is its purity. The Tasmanian Government Analyst obtained by assay 72 per cent. of tungstic acid. Ore of this quality is worth, at present, £160 per ton at Launceston.

In the Bell Mount gold diggings it is estimated that the total gold ore so far won is 4,000 ounces. Nuggets up to 22 ounces have been found, and many weighing from 1 to 2 ounces. This gold is referred to quartz veins in the sandstone and conglomerates of the country, but too little is known of the country lying west of the Wilmot to say whether it has furnished most of the wash or not. The gold has not come far, and search may disclose veins from which it has been detached.

The Devon mine is on the precipitous banks of the Dove river; on the west bank is a galena lode, which varies in width from a few inches up to a foot. Pyrite is present in the gangue, so that the lode may be described as belonging to the pyrito-spathic group of lead-veins, though siderite only occasionally occurs. The output of the mine since 1899 has been 290 tons of silver-lead ore; more than half the quantity assayed 55·9 per cent. of lead, 5 dwts. 4 grains of gold per ton, and 85½ ounces of silver per ton. The high gold contents are unusual for galena from Tasmania.

It is not thought that the chances are in favour of a very high development of any one mineral in this field. The field is more likely to prove one of numerous small and rich lodes.

NEW CANADA AND THE NEW CANADIANS. By Howard A. Kennedy. Pp. 264. (London: Horace Marshall & Son, 1907.)

The author, who has known Canada well for many years, recently visited it again as special correspondent for *The Times*, and embodies in this book his recent articles to that paper, carefully revised and largely re-written. The result is a most interesting book, mainly devoted to the three prairie provinces of Western Canada, Manitoba, Saskatchewan and Alberta, the scenes of great agricultural development at the present time. Lord Strathcona, the High Commissioner for Canada, contributes a preface, in which he says, "I confidently refer those who wish to know something of the great West at first hand, from one who is so competent to give accurate and reliable information, to Mr. Kennedy's volume."

COLONIAL PUBLICATIONS.

Copies of the following publications are available for distribution at the Central Stand in the Exhibition Galleries, free of charge, so long as numbers permit, excepting any to which a price is affixed.

Canada.

ON THE PRAIRIE SECTION OF THE GRAND TRUNK PACIFIC. A map of Manitoba, Saskatchewan and part of Alberta, showing the Dominion land districts, together with a report by Prof. J. Macoun, of the Dominion Geological Survey, on the natural resources of the region.

HAUNTS OF FISH AND GAME. Issued by the Grand Trunk Railway System. A popular and illustrated account of opportunities for sport in various localities, together with abstracts of game and fish laws in Michigan, Ontario, Quebec, New Hampshire and Maine, and detailed maps of the Highlands of Ontario, Temagami and Lake Nipissing.

Transvaal.

THE TRANSVAAL AGRICULTURAL JOURNAL, April 1907. This number of the official journal of the Agricultural Department includes papers on Public Irrigation Works for South Africa, by Sir W. Willcocks, Notes on the Sabi Game Reserve, the Transvaal Agricultural Union, and the usual summaries on matters of interest contributed by the members of the various sections of the Department. The journal is well illustrated.

ANNUAL REPORT. TRANSVAAL DEPARTMENT OF AGRICULTURE, 1905–6. Pp. 322. The volume, which includes a general report by the Director of Agriculture and detailed reports by the heads of the sections of the department, affords much information on the present condition of agriculture in the Transvaal, the chief problems to be solved, and the lines along which work is being conducted.

HANDBOOK TO THE TRANSVAAL. SOUTH AFRICAN PRODUCTS EXHIBITION, 1907. Issued by the Transvaal Department of Agriculture. Pp. 294. A detailed review of this general handbook to the Transvaal and its natural resources has already appeared in this *Bulletin* (p. 196).

West Indies.

BRITISH GUIANA AND ITS RESOURCES. By Prof. J. B. Harrison, M.A., C.M.G., etc. Pp. 40. Pamphlet No. 3. West India Committee, 1907. Price 6*d*. The author, the Government Analytical Chemist and Director of Science and Agriculture for the Colony, describes the

principal physical features of British Guiana. The natural resources classified as (1) agricultural, (2) forest, (3) mineral, (4) power resources, are treated in detail, and statistical information is collected in the appendix.

The pamphlet affords a useful review of the assets, actual and potential, of British Guiana, which, it should be remembered, exceeds Great Britain in area, and, with the exception of the coastal regions, still awaits development.

INDIAN AND COLONIAL COLLECTIONS.

WEST AFRICAN COURT.

GAMBIA EXHIBITS.

THE Colony of the Gambia comprises various small islands (St. Mary's, on which Bathurst, the capital, is situated, being the most important), at the mouth of the river of the same name narrow strips of the adjacent river banks, and McCarthy's Island, 150 miles up the river. The area of the Colony itself is only 69 square miles, but in addition, by the agreement of 1889, British influence extends over a strip of land, about six miles wide, on each bank of the river from the coast nearly up to the Barraconda rapids, some 250 miles inland. The surrounding country on every side, and the whole of the upper reaches of the Gambia River (some 1,400 miles long) is in French Senegal.

The total area of the Colony and Protectorate is 3,061 square miles. In 1903 the population was 163,718.

Physical Features.—The banks of the Gambia, for some distance from the sea, are fringed with mangrove swamps, behind which are plains densely covered with grass, growing to a height of ten feet, and interspersed with clumps of timber. The country is open as compared with the forest-belt region of West Africa, which begins between 60 and 70 miles lower down the coast at the River Casamance.

At a distance of 100 miles from the sea the water of the Gambia is fresh, and the swamps and mangroves gradually give way to steep banks covered with trees, the valley of the river from McCarthy's Island to Barraconda being enclosed by low rocky hills of volcanic formation from 50 to 100 feet high, and the surrounding country being park-like in character.

Climate.—The climate is fairly healthy during the dry season. The mean temperature is 82° F., the annual range being from 60° F. to 104° F. The annual rainfall is 50 inches, the rainy season being from June to October.

Products.—The principal agricultural product of the Gambia is the ground nut, which accounts for more than four-fifths in value of the total exports of the Colony. Rice, guinea corn and millet are largely grown for local consumption. Rubber, palm kernels, beeswax and hides also figure in the export list. A considerable entrepôt trade is done with the French settlements and the adjoining coast districts in cotton goods, spirits, tobacco, rice, cola nuts and hardware.

VEGETABLE PRODUCTS.

Ground Nuts (*Arachis hypogea*). Ground nuts form the principal, indeed almost the only agricultural product of the Gambia. The

quantity exported varies considerably from year to year, the crop depending on the rainfall, the quality of the seed supplied to farmers, and other circumstances. In 1905 the value of the export was £169,426, whilst in the following year it reached £278,055. The bulk of the crop goes to France, to the oil mills of Marseilles and Bordeaux. The finer grades of ground nut oil are employed in the tinning of sardines and as a substitute for olive oil, the lower grades in the manufacture of soap. Ground nut cake, left after the expression of the oil, is a valuable feeding-stuff for cattle. In England picked nuts are employed in confectionery in place of almonds. Ground nuts are also of importance locally as an article of food, being eaten raw, parched or cooked in various ways, *e. g.* as ground nut soup.

Samples exhibited—

Ground nuts.

Rice (*Oryza sativa*). This product is grown to a considerable extent by the natives in the low-lying districts, and forms a large portion of the food of the inhabitants of the Gambia.

Samples exhibited—

Rice.

African Millet or **Koos** (*Pennisetum typhoideum*). This cereal is cultivated on a large scale by the natives, and forms the staple food of the inhabitants of the Colony and Protectorate.

Samples exhibited—

Heads of Koos.

Cassava (*Manihot utilissima*). Cassava or manioc is largely cultivated by the natives. The large tuberous roots when cooked are an important article of food, being rich in the starch from which tapioca is prepared.

Samples exhibited—

Cassava roots.

"**Finde**" (*Digitaria ternata*). A small grass cultivated to a considerable extent by the natives. The seeds are used as an article of food, and serve to tide over the time between the crops of the principal cereals. In Northern Nigeria this plant is known as "Acha," and is used in the same way.

Samples exhibited—

Finde (dry plants).

Maize or **Indian Corn** (*Zea Mays*). Very little maize is grown in the country, the principal food grains being guinea corn, millet and rice.

Sample exhibited—

Maize.

Guinea Corn (*Sorghum vulgare*). Largely grown throughout the Gambia, where it forms one of the principal food grains.

Samples exhibited—

Heads of Guinea corn.
Heads of Guinea corn attacked by smut (*Ustilago* sp.).

Palm Kernels. The kernels or seeds contained in the "stones" of the West African oil palm (*Elæis guineensis*). The soft outer portion of the fruit yields the orange-coloured palm oil, and after this has been extracted there remains the hard stone or nut enclosing the seed or kernel. The latter are obtained by laboriously cracking the stones by hand, or by the aid of a machine such as Miller's nut-cracking machine. The kernels are exported and their oil extracted in Europe. Palm-kernel oil is quite white in colour. It is largely used in the manufacture of soaps. The export of palm kernels from the Gambia is small compared with the dimensions of the trade in most of the West African Colonies, amounting in 1906 to 256 tons of the value of £2,122.

Samples exhibited—

Palm kernels.

Physic Nuts. The fruits of *Jatropha Curcas.* This cosmopolitan plant occurs all over the country, and is largely employed for fencing purposes. The seeds have purgative properties, for which they are much valued by the natives. In order to prepare the seeds for use they are roasted in wood ashes for about ten minutes. Commercially the seeds are of interest in yielding a semi-drying oil, employed in the manufacture of soap and candles. (See *Bulletin of the Imperial Institute*, 1904, **2.** 170.)

Samples exhibited—

Physic nuts.

Coconuts (*Cocos nucifera*). The coconut palm thrives in the lower lands near the sea, and the crop is generally obtained from trees growing under natural conditions. The value of the coconut palm is very considerable locally, because all parts of the tree can be utilised. The wood of the stem is employed in the construction of houses and huts. The leaves are used in thatching huts, and are also plaited into hats, fans, baskets and mats. The husks of the fruit furnish the fibre

known as "Coir," which is made into ropes and matting. The dried kernel known as "Copra," from which oil is expressed, is a valuable commercial product. Coconut oil serves in tropical countries both as a lubricant and as an illuminant, and is imported into Europe to be used in the manufacture of candles and soap. The cake, after the oil has been extracted, is used as a cattle food.

Samples exhibited—

Fruit of Coconut.
Husk of Coconut, "Coir."
Copra.

Indigo. Indigo plants occur wild in the Gambia, and are extensively employed by the natives in dyeing. By the natives of the interior the plant is also used medicinally.

Samples exhibited—

Indigo as used in the dyeing pits.

Rubber. There is now scarcely any rubber in the Gambia itself, and most of that exported comes from French territory.

Samples exhibited—

First-class rubber.
Second-class rubber.
Third-class rubber.
"A" rubber.
"B" rubber.
"C" rubber.

Gum Arabic. The produce of several species of *Acacia*, the most important being *A. Senegal*, a small tree native to West Tropical Africa, and found along the north bank of the River Gambia. The gum exudes naturally from the trunk, but hitherto little industry has been applied by the natives in the Colony to its collection for export. Gum arabic is exported in considerable quantities from the adjoining territory of French Senegal.

Samples exhibited—

Gum Arabic.

Cotton and Cotton Goods. A certain amount of cotton is grown by the natives for local consumption in the manufacture of "Pagns" (native cloth).

Samples exhibited—

Cotton.
Cotton Yarn.
Cloths, dyed and undyed.

Strips of cotton woven on native loom.

Pagns (native cloth).

These form a main article of dress for women and children among such portions of the native population as have not adopted European ways, and until quite recently the inferior qualities were in common use as a means of barter. Genuine native "pagns" woven from native cotton are distinguishable by the stoutness of their texture. Those of finer fabric have a mixture of English yarn which is largely imported from Manchester. The weaving is done on a loom of very primitive construction in strips of not over 6 inches, which are afterwards sewn together to form the "pagn."

Native Cotton Loom.

Fibres. In common with other parts of West Africa various fibre-yielding plants occur wild, and are used locally by the natives for a variety of purposes. Amongst the more important are fibres of the jute type. A general account of the fibres of West Africa is given in the *Bulletin of the Imperial Institute*, 1907, **5.** 1 and 107.

Samples exhibited—

Cran-cran, or Gambia Jute (*Corchorus* sp. ?).
Daissoe Jute (*Corchorus* sp. ?).
Darwaso (*Hibiscus rostellatus*).
Bamba Julo (*Hibiscus quinquelobus*).
Bafando (*Hibiscus tiliaceus*).
Uryrojo.
Bocaranco.
Coana Cray.
Myminsigth.

Mangrove Bark. Samples of this bark have been examined at the Imperial Institute and found to contain about 25 per cent. of tannin. Technical trials prove the bark to produce a soft, light-coloured leather. It is also suited for the preparation of mangrove extract.

Sample exhibited—

Mangrove Bark.

Timbers. Timber fit to cut for export is only obtained in Eastern Kommbo, and even there in no great quantity. West African Mahogany (*Khaya senegalensis*) of remarkably good quality is fairly abundant in certain districts, and is employed locally for the keels of cutters. Rosewood (*Pterocarpus erinaceus*) grows luxuriantly in some parts of the Protectorate, and is employed by the natives in building cutters, bridges, etc.

Samples exhibited—

West African Mahogany.
West African Rosewood.
Incense wood, used in making native furniture.
"Rope Rope," used in boat building.
Rhun Palm, used for piles in the construction of bridges, wharves, etc., on account of its extreme hardness and durability.

ANIMAL PRODUCTS.

Beeswax. This article is obtained from the Kommbo and the Fogni districts, where there is an immense amount of forest land well stocked with bees. The natives collect the wax and sell it in its crude state to the European merchants. The process of clarification is carried out in Bathurst; every mercantile firm possesses machinery for this purpose, and the work is carried out by natives, who very quickly learn the process. It takes about two days to produce a piece of clarified wax similar to the sample exhibited.

The amount of beeswax exported from the Gambia in 1906 was 46,728 lb. of the value of £1,787.

Sample exhibited—

Beeswax.

Hides. There is a considerable and steadily increasing export trade in hides from the Gambia. The number of hides exported in 1906 was 16,802 of the value of £5,201.

Samples exhibited—

Tanned Skin.
Untanned Skin.

MINERAL PRODUCTS.

Gold. There are no mines in the Gambia, and apparently no mineral wealth, although in the past gold has been exported; but this metal did not come from British possessions, but from the far interior beyond Tanda, in French territory, near the source of the Gambia River, and from the streams that later form the River Niger. Gold dust is still occasionally brought into Bathurst from these parts.

Articles of jewellery are made by the natives from this gold. The tribes by whom such jewellery is worn are chiefly the Joloffs and the Sereres inhabiting the north bank of the River Gambia and coast towns from Bathurst in Gambia to St. Louis in French Senegal.

Pure African gold, obtained in small quantities from the interior, is used in the manufacture of these articles, with some admixture of 22 carat standard gold. The design and workmanship are purely native.

MISCELLANEOUS EXHIBITS.

Agricultural Tools and Domestic Utensils.

Pestle and Mortar.
Pestle and Tarpraca, used by women for smoothing native-woven cloths.
Native Hoe.
"Elair," or "Sock Sock" (hoe).
"Dong Cortong" (plough).
Calabashes.

Basket Work.

Harvest Basket.
Fishing Basket.
Straw Tray.
Winnowing Basket.
Cloths Basket.
Jolah Basket.
Marketing Basket.
Travelling Basket.
Native Mats.

Miscellaneous Native-made Articles.

Native Pottery.
Native Knife.
Bush Hat.
Leather Charm.
Leather Sandals.
Native Purse.
Leather Bag.
Decorative Cow's Tail (fly whisk).
Native Charms.
Leather Case.

LIBRARY.—RECENT ADDITIONS.

Books, etc., exclusive of Government Publications, presented to the Library of the Imperial Institute since October 1, 1907.

The United States of Brazil . . . (*Office of the* "*Sphere.*")

Catalogue of the Tropical Products Exhibition, Liverpool, 1907 . . . (*The Secretary.*)

Baumwollenkultur in Deutsch-Ostafrika . H. Akmuth. (*Herr J. Stahl.*)

Calcutta University Calendar for 1907 . (*The Registrar.*)

Transactions of the Institute of Mining and Metallurgy, Vol. xvi., 1906–1907 . (*The Secretary.*)

Official Catalogue of the Bulgarian Section at the Balkan States Exhibition, Earl's Court, London, 1907 . . . . .

Bulgaria of To-day . . . . . . (*The Secretary.*)

Calendar of the University of London, 1907–1908 . . . . . . (*The Principal.*)

Transactions of the Institution of Naval Architects, Vol. xlix., 1907 . . . (*The Secretary.*)

Materials for a Flora of the Malayan Peninsula, Part iii. . . . . . By H. N. Ridley, M.A., F.R.S., F.L.S., F.R.H.S. (*The Author.*)

Report of the Sydney Chamber of Commerce, 1906–1907 . . . . . (*The Secretary.*)

McGill University Examination Papers, 1906–1907 . . . . (*The Registrar.*)

Fourth Annual Report of the Rand Pioneers, with Appendices, 1906–1907 . . . . (*The Secretary.*)

Annual Calendar of McGill College and University, Montreal. Session 1907–1908 . . . . (*The Registrar.*)

The Kalendar of the Royal Institute of British Architects, 1907–1908 . . (*The Secretary.*)

Report of the Perth Chamber of Commerce, 1906–1907 . . . . . (*The Secretary.*)

The Calendar of King's College, London (University of London), for 1907–1908 (*The Secretary.*)

Yoruba String Figures . . . . .

Note on the Asaba People (Ibos) of the Niger . . . . By John Parkinson. (*The Author.*)

Monograph on the Boa Entrada Plantations, S. Thomé	Trans. by Lieut.-Col. J. A. Wyllie, F.R.G.S. (*Mr. Monteiro de Mendonça and the Translator.*)
Rubber Share Handbook . . .	(*Messrs. Gow, Wilson & Stanton, Ltd.*)
Les Plantes Tropicales de Grande Culture, Tome I.—Cafeier, Cacaoyer, Colatier, Vanillier, Bananier	By É. de Wildeman. (*Maison d'Edition, Alfred Castaigne.*)
Calendar of University College, London, 1907–1908	(*The Provost.*)
The Private Diary of Ananda Ranga Pillai from 1736 to 1761, Vol. ii., April to October, 1746	Edited by Sir J. Frederick Price, K.C.S.I., and K. Rangachari, B.A. (*India Office.*)
Transactions of the Royal English Aboricultural Society, Vol. vii., Part i., 1907	(*The Secretary.*)

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Botanical and Zoological names, as well as Titles of Books reviewed, are printed in italics.